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ABSTRACT

To investigate the problem of speechreading failure, a battery of tests was administered to 60 deaf children, half of them poor learners and half good. Results indicated that those who developed speechreading did so at an early age and could deal with words, phrases, and sentences spoken at any rate whereas poor learners comprehended only words spoken slowly. Good learners were superior on measures of intellectual ability, reading comprehension and written language, and sequential and spatial memory. Factorial analyses also indicated that the good learners had more highly integrated and organized mental abilities. Neurological studies revealed more positive neurological signs in poor learners; electroencephalographic studies did not discriminate significantly between the good and poor learners but did distinguish between the brain functioning of deaf and hearing children; ophthalmological studies indicated a high incidence of visual abnormalities in both experimental groups. (Author/JD)

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SPEECHREADING FAILURE IN DEAF CHILDREN

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July 1969

Department of Health, Education, and Welfare
United States Office of Education
Bureau of Education for the Handicapped

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Department of Health, Education, and Welfare

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Bureau of Education for the Handicapped

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A.I.N.
H.R.M.

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SUMMARY

The purpose of this project was to develop further understanding of the psychological, neurological, and ophthalmological processes related to learning to speechread and to study the relationship of failure in such learning to the development of other language abilities. The following questions were studied:

1. Do deaf children classified as good or poor speechreaders differ in ability to lipread messages of variable length and in mastering language sequences spoken at different presentation rates?
2. Does the behavior of deaf children in relation to intellectual functions, visual perception, visual attention span, and visual memory distinguish good speechreaders from those classified as lipreading failures?
3. Is neurological, electroencephalographic, and ophthalmological evidence helpful in explaining failure in learning to speechread?

To investigate the problem of speechreading failure a battery of tests was developed and administered to two groups of deaf children selected from schools in the Metropolitan Chicago area and from the Wisconsin School for the Deaf. One group was designated as Poor Learners and the other as Good Learners. Each group consisted of 30 children equally divided into three age categories: four and five years; six and seven years; and eight and nine years - with an equal number of males and females in each of the groups.

The Poor Learners were pupils who had been unable to develop speechreading and other language skills to the extent expected of deaf children of the same chronological age. Specifically those selected for this group met the following criteria:

1. An average hearing loss for pure tones for the speech frequencies 500 to 2000 Hz of 75 decibels or greater (ISO, 1964 Standards).
2. Average intellectual functioning as measured by a standard nonverbal intelligence test. For the purpose of this study an intelligence quotient of 80 met this criterion.
3. Difficulty in learning to read and write.
4. Inability to use speechreading as a means of communication as determined by the child's teacher and by a pretest of speechreading ability.

5. No additional handicapping conditions, such as lack of visual acuity, emotional disturbance, or generalized motor disability of the cerebral palsy type.

6. Onset of the hearing loss at birth or before the acquisition of language.

Those selected as Good Learners were chosen from the same schools as the Poor Learners and met the same criteria in terms of age of onset, extent of hearing loss, intelligence, lack of visual defects, no significant emotional disturbance, and no primary motor impairment. They differed in that they had demonstrated progress in learning equal to the expected deaf children and had manifested ability to use speechreading as a tool for communication. These subjects were divided into the same age and sex groupings as the Poor Learners.

The study consisted of measures of speechreading (including ability to lipread words, phrases, and sentences at different rates of speed), measures of intelligence, visual perception, motor behavior, and read and written language. In addition, each child was given a complete ophthalmological, neurological and electroencephalographic examination.

The results were highly significant in distinguishing between Good and Poor Learners. Those who developed speechreading did so at an early age and were able to deal with words, phrases, and sentences irrespective of the rate at which they were spoken. In contrast, the Poor Learners comprehended only words and then only when they were spoken slowly.

On all measures of intellectual ability as well as of read and written language, the Good Learners were infinitely superior. Moreover, the Poor Learners were inferior on measures of sequential and spatial memory and, although they had developed average levels of visual perceptual competence, the Good Learners scored unusually high on this function.

The ophthalmological findings did not distinguish between the Good and Poor Learners but these data confirmed previous findings indicating a high incidence of visual abnormalities among deaf children.

The neurological and electroencephalographic studies were highly revealing. The Poor Learners manifested more positive neurological signs, suggesting that at least in some respects neurological dysfunctions and inability to learn normally were associated. The results from the electroencephalographic study were not definitive in relation to good and poor learning. However, perhaps of even more consequence, these findings revealed significant differences in the electrocortical processes of deaf and hearing children. In other words, when deafness was present, brain functioning was altered.

The factorial analyses disclosed more highly integrated and organized mental abilities on the part of the Good Learner. The Good Learner not only had developed capacity to use speechreading as a meaningful tool for assimilating his environment but he was able to integrate symbolic and visual perceptual experience, hence, he was more like the normally hearing child in intellectual attainment and organization.

The implications of this study for the educator of the deaf is that there is a need for greater understanding of the learning processes which pertain when deafness occurs early in life. Realistic educational programs based on this awareness and understanding are requisite to the well-being of deaf children.

INTRODUCTION

Educators are concerned about deaf children who have adequate intelligence but do not learn normally. There is considerable interest in developing programs for the mentally retarded deaf, the deaf-blind, the deaf child with cerebral palsy, and for those with emotional problems (Altshuler, 1963; Hoff, 1963; James, 1963; Mangam, 1963), but there is a larger segment of the population of deaf children, who, despite average intellectual capacity and adequate emotional adjustment, are unable to achieve academically. These do not acquire speechreading, speech, and ability to read according to their potential for learning. At completion of their formal educational training they are more retarded in communication skills than expected even of those profoundly deaf from early life. Estimates of the number of these children range from 15 to 35 percent of those enrolled in educational programs for the hearing impaired (Doctor, 1959; Lowell, 1961; McHugh, 1961). Myklebust (1958, 1960) has stressed that minimal neurological deficits might cause disabilities in reading, writing, and arithmetic, as well as in the use of spoken language. Such learning disabilities may appear also in deaf children.

Studies of language development indicate that reading and writing occur only after considerable experience with auditory language. The normal child does not learn to read until he learns to comprehend and use the spoken word; there must be a period of relating meaningfulness to experience before symbolization of experience can occur. Inner language must be acquired first. Receptive language develops after inner language has been initiated and expressive language is accomplished after comprehension - the child speaks only after he comprehends. Reading and writing are learned initially by the superimposition of the read word on the auditory. Just as a child does not speak until he understands, so a child does not write until he reads. Unless the child develops a considerable body of inner, receptive, and expressive auditory language his capacity to read and write will be limited.

The deaf child is presented with a different and difficult task; he is expected to acquire an auditory verbal symbol system while deprived of the basic input channel for accomplishing it. His symbol system must be visual or tactile-kinesthetic, or both. The marked limitation of the deaf in language functioning has been thoroughly documented. The studies of Furth (1966) and Myklebust (1964) have suggested that this failure may stem from a lack of development of inner and receptive language. Because vision is the deaf child's basic channel for language learning, his must be a visual symbol system despite the fact that vision is less suitable as a channel for acquiring a basic language system. Because reading requires a high level of developmental maturity it does not serve the purpose of a symbol system to be acquired in early childhood. The alternatives for the deaf are speechreading and the manual language of signs. Sign language for the young deaf child, because of its ideographic nature has limited value for the development of a verbal symbol system. Although speechreading also has limitations as compared with auditory language, it can become the basic inner language system for the deaf child, who then can think in words. It follows that as speechreading skill develops the ability of the child to adjust to and manipulate his environment through language is enhanced. Furthermore, evidence indicates that the deaf person highly competent in speechreading also is competent in reading as well as in speech.

Just as a childhood aphasia interferes with development of auditory language, and later in the development of reading and writing, so speechreading aphasia seriously interferes with the deaf child's development of language. Hence, in this research we have attempted to analyze speechreading disorders as well as the nature of speechreading as a process.

Speechreading aphasia has been defined as the inability to relate the word (symbol) seen on the lips with its meaning. The child cannot associate the word and the unit of experience which it symbolizes. It is a receptive language disorder comparable to receptive aphasia as seen in both children and adults; the individual cannot relate the heard word to its meaning.

It is assumed that there are degrees of speechreading aphasia. The most obvious is an incapacity to imitate speech movements. Presumptively, unless the speech movements can be internalized and imitated they cannot be integrated as a language form.

Another cause of failure is lack of sequencing ability; the child may be able to retain isolated lip movements but be unable to unite two or more movements to form words. Another possibility is that he is unable to hold a number of lip-read words in mind, hence he fails to understand the thought (sentence). Simmons (1959) and Costello (1957) have stressed the importance of sequencing ability in the development of speechreading.

A further cause of failure is the speechreader's inability to comprehend when spoken to at a normal conversational rate. This is failure to develop ability to speechread because of rate deficiencies in the encoding process.

A third type of failure may be similar to the condition observed in children with normal hearing who are unable to perceive body movements of differences in these movements. Formerly it was hypothesized that speechreading aphasia and dyslexia were analogous, perhaps deriving from damage to the same areas of the brain. However, it appears that speechreading and reading are not identical neurologically or psychologically; the latter requires perception of a stationary image on a page, while the former entails the perception of momentary movement. Neurologists have suggested that the disturbance of parietal lobe functioning may result in faulty perception of body image, self perception, and person perception. Failure to derive symbolic meaning from lip movements may be related to the inability to normally perceive body parts, especially faces. Some individuals having speechreading aphasia may lack capacity to recognize faces, a condition referred to as anosagnosia (Myklebust, 1964).

In the initial development of reading it is typical for the child to "sound out" letters and to blend them into words. Even very few adults can read without some form of reauditorization which serves to reinforce the association of the visual and auditory symbol. The equivalent situation is the unconscious imitation of lip movements by good speechreaders. This process may be considered a form of proprioception requiring the observer to perceive the lip movements and to relate them to how they feel on his own lips and articulators. An inability to integrate kinesthetic and proprioceptive sensations may result in failure to imitate speech positions and prevent further internalization and learning of the speechread symbol.

Although educators of the deaf have accepted speechreading as being the most suitable means for developing verbal symbolic language in those with profound hearing losses, little study has been devoted to the question of why individuals fail to develop speechreading ability. Knowledge of the processes contributing to this failure would lay the groundwork for educational procedures to overcome this language deficit. In addition, understanding of this underlying dynamics would permit development of clinical techniques for identifying these children so that educational remediation could be instituted.

The purpose of the project was to develop further understanding of the psychological and neurological processes which result in failure to develop speechreading skills and to determine the relationship of this failure to the development of other language processes. The following questions were studied:

1. Do deaf children classified as good or poor speechreaders differ in ability to lipread materials of variable length, and in mastering materials spoken at different presentation rates?

2. Does the behavior of deaf children in relation to intellectual functions, visual perception, visual attention span, and visual memory distinguish good speechreaders from those classified as lipreading failures?

3. Is neurological, electroencephalographic, and ophthalmological evidence helpful in explaining failure in learning to speechread?

PROCEDURES

SUBJECTS

To investigate the causes of speechreading failure a battery of tests was developed and administered to two groups of deaf children selected from schools in the Metropolitan Chicago area and from the Wisconsin School for the Deaf. One group was designated as Poor Learners and the other as Good Learners. Each group consisted of 30 children equally divided into three age categories: four and five years; six and seven years; and eight and nine years--with an equal number of males and females in each of the groups.

The Poor Learners were comprised of pupils who had been unable to develop speechreading and other language skills to the extent expected of deaf children of the same chronological age. Specifically those selected for this group met the following criteria:

1. An average hearing loss for pure tones for the speech frequencies 500 to 2000 Hz of 75 decibels or greater (ISO, 1964 Standards)
2. Average intellectual functioning as measured by a standard nonverbal intelligence test. For the purpose of this study an intelligence quotient of 80 met this criterion; such a quotient is acceptable for inclusion in the regular school program for the hearing impaired.
3. Difficulty in learning to read and write.
4. Inability to use speechreading as a means of communication as determined by the child's teacher and by the pretest of speechreading ability.
5. No additional handicapping conditions, such as lack of visual acuity, emotional disturbance, generalized motor disability of the cerebral palsy type.
6. Onset of the hearing loss at birth or before the acquisition of language.

Those selected as the Good Learners were chosen from the same schools as the Poor Learners and met the same criteria in terms of age of onset, extent of hearing loss, intelligence, lack of visual defects, no significant emotional disturbance, and no primary motor impairment. They differed in that they had demonstrated progress in learning equal to that expected of deaf children and had manifested ability to use speechreading as a tool for communication. These subjects were divided into the same age and sex groupings as the Poor Learners.

A total of 81 deaf children were screened and from this number 60 were selected for further investigation. Of those selected for the study 38 (22 Good Learners and 16 Poor Learners) were drawn from the programs of the Chicago area schools and 22 (eight Good Learners and 14 Poor Learners) were from the Wisconsin School for the Deaf. Evaluation of the case history material obtained from each subject indicated no essential difference between the groups in terms of etiology or age of onset. Only six of the children were reported to have been born with normal hearing and of this number all had lost their hearing before the age of two. As noted in Table 1 the groups were evenly matched for chronological age with the mean age falling at the midpoint of each age range.

DESIGN

Prior to the administration of the test battery the school records were examined to select a potential pool of subjects. Identifying information and data concerning socioeconomic status, the degree of deafness, etiology, and age of onset were noted along with details concerning emotional adjustment and problems of visual acuity. Preliminary assignment as Good or Poor Learner was made on the basis of previously administered intelligence tests and tests of educational achievement, as well as from diagnostic information derived from tests employed as part of the study.

The test battery was of two types, procedures which provided diagnostic data concerning the subjects, and techniques which provided data for testing the hypotheses that had been formulated.

METHODS

Audiometric Assessment

The hearing level of each subject was determined through the use of formal pure tone audiometric techniques, using a Beltone 9A audiometer calibrated to ISO standards. When indicated, both air and bone conduction audiograms were obtained.

Intelligence Levels

The Hiskey-Nebraska Test of Learning Aptitude (1966 revision) was administered to all subjects. This test has been accepted as a measure of intellectual functioning of young deaf children. The recent restandardization (Giangreco, 1966) appears to have improved the reliability and validity of this test as a diagnostic instrument; it requires no adaptation to be administered to the hearing impaired, being designed to meet the special needs of the deaf. The eight subtests recommended for use with children under 11 years of age were administered; these included Bead Pattern, Memory for Color, Picture Identification, Paper Folding, Visual Attention Span, Block Patterns, and Completion of Drawings. No difficulties were encountered in administering the test to any of the subjects.

TABLE 1

THE MEAN CHRONOLOGICAL AGE OF THE SAMPLE IN MONTHS

	Poor Learners			Good Learners		
	N	Mean	S.D.	N	Mean	S.D.
4 & 5 yrs.	10	56.3	10.75	10	56.2	7.83
6 & 7 yrs.	10	85.3	4.24	10	83.3	7.94
8 & 9 yrs.	10	110.5	6.95	10	105.0	8.35

Educational Achievement

It was intended originally to employ the Gates Primary Reading Tests as a measure of read language. However, before the project was inaugurated this test went out of print. The Metropolitan Achievement Battery, Primary I and II, having proved to be a reliable measure, was substituted. This battery was administered to all subjects above six years of age; however, consistent results were obtained only from the oldest group. Three sections of the Metropolitan Test - Word Knowledge, Reading, and Arithmetic - were used.

Written Language

The Picture Story Language Test (Myklebust, 1965) was used as a measure of written language. This test can be administered with little difficulty and has proved to be useful in analyzing the language problems encountered by the deaf child. The child is required to write a story about a picture. The story is scored for productivity (total number of words per sentence); for thought (the Abstract/Concrete Score); and correctness of grammar (the Syntax Score). Normative data for both hearing and deaf children have been presented (Myklebust, 1964, 1965).

Speechreading Ability

Teachers' ratings served as a preliminary estimate of the child's ability to use speechreading as a receptive language. Additional data were obtained to validate these ratings. A series of motion picture films had been produced for "machine" teaching a specific lipreading vocabulary, using an eight millimeter self-winding cartridge load projector. With support from the United States Office of Education, a research project had previously demonstrated the efficacy of this method. Included in the project was a filmed lipreading test based on the vocabulary which was taught. The test film portrayed a trained teacher of the deaf speaking as she would to a group of deaf children. The test consisted of 66 words divided into four levels of increasing difficulty. The film was projected on a rear view screen in a partially lighted room. The subject was seated before the screen with the examiner beside him. After the word was seen as spoken the examiner turned off the projector and pointed to a card containing five pictures, one of which depicted the word spoken. The subject indicated the picture which he felt represented the filmed word. In the demonstration project the filmed test distinguished between those classified as good lipreaders and those rated as poor. Therefore, this test was used in the present study to validate the teachers' ratings and as a basis for assigning subjects to the classification as a Good or Poor Learner.

Neurological Functions

Each subject was seen for neurological and electroencephalographic study. The neurological examination was conducted at the staff offices of Evanston Hospital by a trained neurologist, who also acted as consultant to the project. Following this examination the electroencephalogram was obtained. All of the electroencephalographic studies were performed at the hospital by a trained technician. Each record was read and interpreted by a member of the faculty of the Department of Neurology and Psychiatry at Northwestern University Medical School, who is a scientist in this field. To obtain additional diagnostic information a series of motor tests were administered; included were the Heath Rail Test, measures of laterality, and strength of grip as measured by the Smedley Dynamometer.

Ophthalmological Aspects

An ophthalmological examination was completed for each subject. The majority of the examinations were conducted at Evanston Hospital; for the subjects at the Wisconsin School for the Deaf a special clinic was organized at the school's infirmary by our ophthalmological consultant; the same ophthalmologist examined all subjects.

EXPERIMENTAL VARIABLES

The experimental battery was designed to test the hypotheses postulated as possibly explaining failure to learn speechreading. This battery was comprised of the following:

Sequencing

The tests of sequencing were of three types: words, phrases, and sentences. The words selected for this series were chosen after a review of curricula as found in programs for the hearing impaired. It included the vocabulary that the subjects had been exposed to and with which generally they were familiar. An effort was made to include all of the parts of speech in proportion to their use by the deaf (Myklebust, 1964, 1967). From this pool 36 words were chosen: 18 of one syllable, nine possessing two syllables, six with three syllables, and three words with four syllables. From these words 10 phrases and 20 sentences were constructed; the phrases ranged from two to six syllables, while the sentences began with three syllables and increased in difficulty to 12 syllables. For each stimulus a response card was constructed containing four pictures, one of which represented the message spoken. The response pictures were drawn by a qualified artist; in selecting the speechreading items and the pictures, an effort was made to avoid ambiguity. As rate of utterance was one of the parameters studied, two additional forms of the test were constructed, using the available word pool; the complete test represented a total of 198 items.

Rate

To determine the effect of speed of utterance on speechreading a sequencing test was constructed; it included three forms designated A, B, and C. Each form was filmed on eight millimeter Kodachrome motion picture film using an experienced teacher of the deaf as the speaker. In Form B the speaker was instructed to say the words at the rate usually employed in talking with her class, a speed of presentation somewhat slower than used when talking with normally hearing children. The test items were filmed at the rate of 24 frames per second and were projected at the same speed.

In Form A the speaker said the words, phrases and sentences at a slower speed, also filmed at the rate of 18 frames per second which in effect slowed the rate of presentation one third.

For the third form the speaker uttered the stimulus material at a normal conversational rate. To approximate this rate a group of five normally hearing graduate students in deaf education recited the material as they would in regular discourse. The time for each utterance was recorded and averaged. The test speaker then practiced until she approximated this rate which then was recorded on film; as with the other two forms the material was filmed at the rate of 24 frames per second. For the purposes of the study the films were edited and loaded into self-winding cartridges to be projected through the Technicolor eight-millimeter cartridge load projectors. Before beginning the research project a pilot study was undertaken with a group of 28 pupils from the Lutheran School for the Deaf in Detroit (ranging in age from four to 13 years) and with 10 older students from the Wisconsin School. The group from the Lutheran School was considered good or excellent in speechreading ability; the three forms of the speechreading protocol were administered and the results tabulated. The data obtained demonstrated that those who were classified as good or excellent lipreaders performed equally well on all three forms regardless of speed of presentation, indicating that the forms were equivalent in difficulty. Significant differences in performance were noted between the various age levels, with the thirteen year olds achieving almost perfect scores. The ten children from the Wisconsin School for the Deaf included both good and poor lipreaders; all three forms were administered twice, each child being seen no later than three weeks after the initial presentation. No significant differences in the scores for each presentation were noted, suggesting that a single administration might be a reliable indicator of facility in speechreading.

As a second part of the study of rate as a variable it had been planned to explore the question of whether the deaf child learned more effectively at faster or slower rates following the procedures described by Neyhus (1967). However, after a series of training sessions with a group representing all of the ages included in the study, little appreciable learning was observed. Hence, it was concluded that a considerably longer period of time would be necessary if meaningful data were to be obtained. Accordingly, it became expedient to view the learning study as a separate investigation to be completed in the future; ample data could be secured to test the present hypotheses.

Visual Perception

In addition to the subtest items of the Hiskey-Nebraska Test, a number of procedures were introduced to measure visual memory and visual perceptual behavior; these included the Knox Cube Test (Arthur, 1947) and the Tapping Test from the Ontario School Ability Examination (Amoss, 1947). The Tachistiscopic procedures as described by Myklebust and Brutten (1953) also were included, employing the same stimulus material. These items were: Pattern Reproduction, Dot Reproduction, and Figure Ground. The subject was seated in a chair before a movie screen in a semi-darkened room; the Keystone Tachistoscope was placed to the right behind the subject. The distance from the screen to the projector was set so that the test stimuli projected an image one foot square. For the Figure Ground series the images remained on the screen for 1/10th of a second while the subject indicated his response by selecting one of four figures from a response card. For the reproduction test the stimulus materials comprised ten geometric patterns, five of which were line patterns and five consisted of dots. The patterns were exposed at lengthening durations (1/100th second, 1/50th, etc. and one second) until the subject correctly reproduced them with the exposure time noted. If the one-second exposure was not sufficient to produce an accurate reproduction, the stimulus was given a time exposure and the subject permitted to copy it from the screen.

Originally it was intended that a test battery to measure proprioceptive behavior, through use of the glossal transducer, be included. Because of difficulties encountered in developing the instrumentation, we decided to relinguish this part of the battery.

TESTING ROUTINE

Because of the length of the battery, administration of the various test sections was undertaken in a number of sessions, lasting from one to two hours each. An attempt was made to group the tests according to their content, e.g. the intelligence test items, the motor, and speechreading. Except for tests of reading, writing and arithmetic all items were administered individually. The medical examinations, except for those ophthalmological studies completed at the Wisconsin School for the Deaf, were undertaken in appropriate settings. A case history was obtained from all but three of the parents, either in the school setting or at the hospital. Generally, the hearing tests, the intelligence tests, and the pre-tests of speechreading were administered first. The remaining evaluations were undertaken when convenient. The total time for the battery was six and one-half hours per subject.

PSYCHOEDUCATIONAL STUDY

CASE HISTORY

The criteria for selection of subjects included a presumption of normal intelligence and average hearing levels of 75 dB or greater for the speech frequencies 500 Hz to 2000 Hz. Children were assigned to the Poor or Good Learners according to the teachers' ratings of speechreading ability and performance on a lipreading pretest. To determine the influence of socioeconomic or educational factors a case history was obtained through interview. The case history data were analyzed employing discriminant analysis techniques; the results revealed no significant differences between the groups. They were essentially similar in family backgrounds and early life experience.

There has been speculation that deaf children with high socioeconomic status tended to be better in speechreading skills because of the greater verbal fluency of the home environment. An analysis of the socioeconomic status of the sample as represented by the parents' occupation is presented in Table 2.

These data suggest a higher financial level for the research population in comparison with general levels; none of the parents were in the unskilled manual classification and fewer than expected were among the semi-skilled (expected percentage, 27.7[1]). The majority of the parents of the Poor Learners (59.2 percent) were in the skilled manual or clerical classification while in the Good Learners more were in the professional and sub-professional categories (65.4 percent). This difference, however, was not statistically significant ($X^2 = 6.36$). The social status of the subjects reflected their total community background.

The level of academic achievement, Table 3, was higher than the ninth or tenth grade generally reported for the nation. The Good Learners' fathers had a median educational level of two years of college while the Poor Learners' fathers had completed high school; 44.4 percent of the Good Learners' fathers had received a college degree. The median educational level of the mothers was twelfth grade. Despite higher levels of academic achievement for the Good Learners' parents, the differences were not statistically significant ($X^2 = 3.00$).

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[1] Source: U. S. Bureau of the Census, Current Population Reports: Population Characteristics, "Educational Attainment: March, 1957," (1960)

TABLE 2

BECKMAN SCALE RATINGS OF PARENTS' OCCUPATIONS[a]

Grade	Type of Occupation	Poor Learners (N=27)		Good Learners (N=26)		Total (N=53)	
		N	%	N	%	N	%
I	Unskilled Manual	--	--	--	--	--	--
II	Semi-skilled	1	3.7	2	7.7	3	5.7
III-A	Skilled Manual	9	33.3	7	26.9	16	30.1
III-B	Skilled Clerical	7	25.9	--	--	7	13.3
IV-A	Sub-Professional	2	7.4	2	7.7	4	7.6
IV-B	Proprietor	--	--	1	3.8	1	1.9
IV-C	Supervisory	4	14.8	4	15.4	8	15.2
V-A	Professional Linguistic	2	7.4	4	15.4	6	11.4
V-B	Professional Scientific	2	7.4	6	23.1	8	15.2
V-C	Executive	--	--	--	--	--	--

[a] See Bingham, W. _Aptitude and Aptitude Testing_. New York: Harper, 1942.

TABLE 3

HIGHEST GRADE LEVEL ACHIEVED BY SUBJECTS' PARENTS

	Father				Mother			
	Poor Lrnrs.		Good Lrnrs.		Poor Lrnrs.		Good Lrnrs.	
Grade	N	%	N	%	N	%	N	%
8	2	7.4	--	--	--	--	--	--
9	--	--	1	3.7	1	3.7	1	3.7
10	3	11.1	1	3.7	4	14.8	1	3.7
11	1	3.7	2	7.4	--	--	--	--
12	11	40.7	9	33.3	12	44.4	15	55.5
1 yr. Coll.	1	3.7	--	--	2	7.4	1	3.7
2 yr. Coll.	2	7.4	2	7.4	2	7.4	4	14.8
3 yr. Coll.	1	3.7	--	--	2	7.4	--	--
4 yr. Coll.	3	11.1	9	33.3	3	11.1	5	18.5
5 yr. or more Coll.	3	11.1	3	11.1	1	3.7	--	--
Median	12th Grade		2 yr. Coll.		12th Grade		12th Grade	

Pintner (1916) in writing of the hearing impaired child's educational and apparent "mental retardation" felt that the factors involved in the etiology of the hearing loss also accounted for their poor educational achievement. Today's educators reflect concern that there is a higher proportion of deaf children with central nervous dysfunctioning which prevents learning beyond the deprivation caused by the hearing loss alone. In Tables 4 and 5 are presented the data concerning etiology. Over half of the Good Learners (56.1 percent) were classified as endogenous while 50.0 percent of the Poor Learners were considered exogenous. Although there were more with hereditary deafness in the Good Learners the difference was not significant ($X^2 = 5.74$). It is interesting to note that of the total number of subjects, 41.1 percent were of the familial type, a figure reported consistently among the deaf; 18, or 30 percent had losses presumably as a complication of pregnancy or birth; 43, or 71.6 percent, had a history of causation from which the presumption was made that the hearing loss was present at birth. For the 11 children for whom there was no known etiology it was the parents' belief that deafness was present at birth; a total of 54 subjects, or 90 percent, were presumed to be congenitally deaf. Of the remaining, six lost their hearing by their first birthday while the three meningitics suffered their losses during their second year of life.

Educators have stressed the value of early diagnosis and training to overcome the effects of a profound hearing loss; that formal training be undertaken immediately to enhance development of speechreading. The data in Tables 6 and 7 do not support this hypothesis; there was no difference between the groups in the age of discovery of the hearing loss, the time at which the loss was confirmed, nor in the age of the initiation of training. For those born deaf, the parents' suspicions were aroused by 11 months of age, but it was not until the child was about a year and a half that the loss was confirmed; by two and a half years formal training was begun. On the average 20 months elapsed from the time that the hearing loss was suspected to the beginning of training. Of the 50 parents reporting, 25 children (13 Poor Learners and 12 Good Learners) were enrolled in hospital or university clinics before entering public schools; two Poor Learners and five Good Learners received training at home on an informal basis. There was no difference in the pattern of suspicion, confirmation and initiation of training that related to socioeconomic status.

In summary, the case history information revealed that the Good and Poor Learners were similar in family background, socioeconomic status, etiology, age of onset and exposure to early training. The level of previous educational experience also was equivalent.

HEARING LEVELS

An average hearing level of 75 dB for the speech frequencies 500 to 2000 Hz in the better ear was one of the selective criteria. The results of the audiometric testing are presented in Table 8. The better ear average for the Poor Learners was 102.6 dB and for the Good Learners, 99.2 dB; the difference was not significant ("t" = 1.47). For the right ear the average for the Poor Learners was 105.6 dB and for the Good Learners, 101.2 dB, a difference which was significant ("t" = 2.04, $p \leq .05$).

TABLE 4

SPECIFIC ETIOLOGY OF HEARING LOSS BY GROUP

Etiology	Poor Learners		Good Learners		Total	
	N	%	N	%	N	%
Undetermined	7	23.1	4	13.2	11	18.7
Maternal Rubella	2	6.6	5	16.5	7	11.9
Other Maternal Illness	2	6.6	2	6.6	4	6.8
Complications in Pregnancy	3	9.9	--	--	3	5.1
Premature Birth	1	3.3	--	--	1	1.7
Rh Incompatability	1	3.3	--	--	1	1.7
Birth Complications	1	3.3	1	3.3	3	3.4
Familial (Genetic)	8	26.4	17	56.1	25	42.3
Meningitis	3	9.9	1	3.3	4	6.8
Childhood Diseases	2	6.6	--	--	2	3.4

TABLE 5

CATEGORICAL COMPARISON OF ETIOLOGICAL FACTORS BY GROUP

Etiology	Poor Learners N	Poor Learners %	Good Learners N	Good Learners %	Total N	Total %
Endogenous	8	26.7	17	56.7	25	41.7
Exogenous	15	50.0	9	30.0	24	40.0
Unknown	7	23.3	4	13.3	11	18.3

TABLE 6

AGE IN MONTHS OF DISCOVERY OF HEARING LOSS AND INITIATION OF TRAINING

Group	N	Age Loss Suspected Mean	Age Loss Suspected S.D.	Age Loss Confirmed Mean	Age Loss Confirmed S.D.	Age Training Initiated Mean	Age Training Initiated S.D.
Poor Learners	27	11.6	9.90	17.6	10.08	34.8	14.49
Good Learners	26	10.7	6.97	19.1	8.29	28.5	15.54
Total	53	11.2	8.51	18.4	9.78	30.1	15.15

TABLE 7

NUMBER OF MONTHS FROM AGE OF DISCOVERY OF HEARING LOSS UNTIL INITIATION OF TRAINING

		Suspicion to Confirmation		Confirmation to Initiation of Tr.		Suspicion to Initiation of Tr.	
Group	N	Mean	S.D.	Mean	S.D.	Mean	S.D.
Poor Learners	27	5.9	6.68	17.2	13.65	22.6	12.44
Good Learners	26	8.4	7.34	8.9	11.96	18.1	12.91
Total	53	7.6	7.12	13.2	13.59	20.6	12.76

TABLE 8

SUBJECTS' AVERAGE HEARING LEVEL BY GROUP[a]

	Poor Learners						Good Learners					
	Male		Female		Total		Male		Female		Total	
Frequency Range	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
500 Hz to 2000 Hz												
Right Ear	105.5	5.36	105.8	8.34	105.6	7.01	101.9	9.89	100.6	8.60	101.2	9.29
Left Ear	106.5	6.36	105.2	6.42	105.5	6.51	104.0	9.69	102.9	7.90	103.5	8.86
Better Ear	102.1	6.33	103.0	8.38	102.6	7.41	100.1	10.89	98.3	8.51	99.2	9.81
Fletcher Average 500 Hz to 2000 Hz												
Right Ear	102.6	6.59	100.3	8.79	101.5	7.85	94.4	9.74	97.9	7.06	96.1	8.13
Left Ear	101.3	7.66	103.6	7.45	102.5	7.64	98.0	9.36	97.4	6.31	97.7	2.32
Fletcher Average 250 Hz to 4000 Hz												
Right Ear	93.6	11.74	88.8	9.70	91.2	11.01	82.7	11.19	87.4	10.35	85.1	11.03
Left Ear	90.5	13.98	82.1	8.59	91.3	11.63	84.3	9.77	88.3	6.56	86.4	8.57

[a] Hearing levels in decibels re. 1964 I.S.O. Standards.

The hearing levels for the left were essentially similar.

To explore further the relation of hearing to speechreading the average of the two best frequencies (Fletcher Average) for the speech frequencies was computed. The results revealed the Good Learners to average 5 dB better hearing in both ears ("t" = 2.54) for the right ear and 2.32 for the left, $p \leq .05$). When the analysis was extended to 250 Hz and to 4000 Hz the difference in favor of the Good Learners appeared only in the right ear.

Preliminary analysis indicates that an association exists between hearing levels and speechreading skills even among those with profound impairment. Although the better ear averages were essentially similar, the Good Learners had less of a loss when each ear was considered separately. Of interest was the finding that this difference appeared more frequently in the right ear. Brannon (1964) reported similar findings regarding the relationship of hearing levels for the right ear and oral communication skills even among the profoundly deaf.

SPEECHREADING

The speechreading battery comprised words, phrases and sentences (presented at different speeds) developed to measure the effects of length of utterance, rate of presentation, and meaningfulness of material upon lipreading skill. Correctness of response depended on selection of a picture which was directly related to the stimulus; the subject made a choice among four illustrations.

The subjects were classified on the basis of their teachers' ratings and performance on the speechreading pre-test. The test consisted of a filmed presentation of 66 words used in the Bell School Study and spoken by a trained teacher of the deaf, projected through a cartridge load self-winding eight millimeter film projector. The subject indicated his response by selecting a picture. For the present study all 66 words were presented while in the Bell project the subject viewed only those words considered appropriate for his age level. The results are presented in Table 9. For comparison the scores of the Good and Poor Speechreaders from the Bell Study also are presented. (The subjects in the Bell Project were divided into two groups only on the basis of teachers' ratings.)

These findings reveal that the Good Learners consistently outscored the Poor Learners at all levels. At the two youngest age levels, the Poor Learners' scores of 17.0 and 28.8 were little better than chance; while the Good Learners' scores were two times greater. In the Bell School study a similar pattern was observed except that at the oldest age level no significant differences appeared. At all age levels the scores for the Poor Learners were similar to those achieved by those classified as the poor lipreaders in the Bell School Study. Except for the youngest children the Good Learners attained scores which were almost identical with those from the Bell Study who were found to be good speechreaders.

The results derived from the speechreading battery are presented in Tables 10 to 24. Table 10 depicts the data for the four and five

TABLE 9

SPEECHREADING PRETEST SCORES FOR PRESENT AND PREVIOUS SAMPLES

	Present Study							Bell Study						
	Poor Learners			Good Learners				Poor Sp.Rdrs.			Good Sp.Rdrs.			
	N	Mean	S.D.	N	Mean	S.D.	"t"	N	Mean	S.D.	N	Mean	S.D.	"t"
4 & 5 yrs.	10	17.0	13.14	10	35.0	15.33	2.59*	9	17.0	9.49	12	61.5	20.94	3.41**
6 & 7 yrs.	10	28.8	10.26	10	59.3	7.39	4.87**	15	24.1	13.08	9	60.8	12.62	6.55**
8 & 9 yrs.	10	53.1	15.18	10	67.7	10.43	2.38*	7	54.0	14.92	6	68.8	16.9	1.59

* $p \leq .05 = 2.10$
** $p \leq .10 = 2.88$

TABLE 10

PERCENTAGE CORRECT SCORES FOR SPEECHREADING BATTERY: FOUR AND FIVE YEAR OLDS

	Poor Learners					Good Learners					Total				
	Male (N=5)		Female (N=5)			Male (N=5)		Female (N=5)			Good Lrnrs. (N=10)		Poor Lrnrs. (N=10)		
	Mean	S.D.	Mean	S.D.	"t"	Mean	S.D.	Mean	S.D.	"t"	Mean	S.D.	Mean	S.D.	"t"
Form A															
Words	35.4	16.55	19.0	10.97	1.65	54.6	10.69	52.0	21.88	.21	27.2	16.26	53.3	17.27	3.30**
Phrases	30.0	21.91	34.0	19.60	.27	52.0	13.27	48.0	19.39	.34	32.0	20.88	50.0	16.73	2.02
Sentences	30.0	16.43	20.0	14.14	.92	43.0	16.31	39.0	18.82	.32	25.0	16.12	41.0	17.72	2.00
Phrases & Sentences	29.8	15.14	24.6	15.43	.50	45.8	14.41	41.8	15.69	.32	27.2	15.02	43.8	15.20	2.33
Form B															
Words	32.8	6.74	23.0	7.90	1.89	47.2	14.92	56.4	20.00	3.11*	27.9	8.83	51.8	18.23	3.54**
Phrases	22.0	11.66	22.0	23.15	0.00	32.0	17.20	38.0	7.48	.64	22.0	18.33	35.0	13.60	1.71
Sentences	32.0	9.27	17.0	10.77	2.11	49.0	20.83	28.0	16.61	1.58	24.5	12.54	38.5	21.57	1.68
Phrases & Sentences	28.8	8.82	18.8	12.35	1.25	43.2	19.10	32.6	15.30	.87	23.8	12.37	37.9	18.10	1.93
Form C															
Words	40.6	15.27	22.6	14.29	1.72	56.2	16.84	53.8	19.64	.19	31.6	17.31	55.0	18.24	2.79*
Phrases	34.0	10.20	14.0	18.55	1.89	40.0	20.00	44.0	14.97	.32	24.0	18.00	42.0	17.78	2.13*
Sentences	34.0	4.90	22.0	16.91	1.36	43.0	12.49	38.0	16.31	.49	28.0	13.82	40.5	14.74	1.86
Phrases & Sentences	34.2	4.87	19.4	13.89	2.01	40.0	16.60	40.0	15.49	.00	26.8	12.77	40.0	16.06	1.93
Total Battery															
Words	36.2	11.09	21.4	9.50	2.03	52.6	12.99	54.4	19.74	.15	28.9	12.70	53.5	16.74	3.53**
Phrases	28.8	12.24	23.6	16.56	.50	41.2	13.02	43.4	12.24	.25	26.2	14.79	42.3	12.69	2.48*
Sentences	32.2	6.68	19.6	13.35	1.69	44.2	16.17	35.2	16.90	.77	25.9	12.29	39.7	17.14	1.96
Phrases & Sentences	30.8	7.83	20.8	12.86	1.33	43.2	14.72	38.0	14.44	.50	25.8	11.76	40.6	14.81	2.35*

* for N = 10 $p \leq .05 = 2.31$

* for N = 20 $p \leq .05 = 2.10$
** for N = 20 $p \leq .01 = 2.88$

year olds. (The raw scores consisting of the number of items correct have been converted to quotients to permit comparison among the various type of stimuli.) Both for the Poor Learners and for the Good Learners only one comparison revealed a sex difference, the Good Learner females displaying better performance on Form B Words (the speed of presentation usually employed with the deaf). This result could have occurred by chance as in over 48 different comparisons of male and female performance only one other significant difference was noted and this favored the males.

Regardless of speed of presentation the Good Learners were superior to the Poor Learners in ability to speechread single words. For the poor lipreaders their mean score was barely above the level of chance while the Good Learners scored correctly on approximately half of the words. The Good Learners tended to perform better on sentences (attaining 40 percent accuracy) than the Poor Learners but the differences were not significant. On Form C (normal conversational speed for the hearing), the Good Learners were superior in their response to phrases. The Poor Learners at this young age were unable to speechread any stimuli regardless of the type and the rate of utterance. The Good Learners not only were able to identify correctly 50 percent of the words but derived meaning from about 40 percent of the phrases and sentences.

As age increased scores on all stimuli improved. For the six and seven year old deaf, Table 11, sex differences appeared among the Poor Learners, especially on the word tests. The male Poor Learners performed no better than the younger children, their scores occurring primarily by chance. The females performed more like four and five year odl Good Learners. Inspection of the scores suggested that the better performance of the girls may have been influenced by a subject who, despite evidence that she belonged in the category of poorer speechreaders, managed to achieve fairly well on the battery. The Poor Learner groups combined demonstrated ability to speechread words at a level of 45 to 50 percent, while scores for the more complex material (phrases and sentences) ranged slightly beyond the chance level. The Good Learners, on the other hand, consistently achieved scores of 85 percent accuracy for words and demonstrated an understanding of two-thirds to three-fourths of the more complex material, depending on the speed of presentation. The Good Learners were significantly superior for every comparison at this age level.

At the highest age level, Table 12, the Good Learners were superior on almost all comparisons. These Poor Learners attained scores ranging from 70 to 78 percent for Words, and 45 to 60 percent for Phrases and Sentences; the Good Learners averaged about 90 percent for Words and 60 to 90 percent for Phrases and Sentences, again depending on the rate of utterance. At all age levels and on all types of stimuli the Speechreading Battery clearly distinguished between Good and Poor Learners.

Further analysis of the data, Tables 13 to 19, reveals a pattern of speechreading development which differed for the Good and Poor Learners. At age four to five, the mean scores for the Poor Learners were little better than chance; from six to seven years this age group attained 46.7 percent accuracy on the words and at nine years a mean score of 70 percent was attained.

TABLE 11

PERCENTAGE CORRECT SCORES FOR SPEECHREADING BATTERY: SIX AND SEVEN YEAR OLDS

	Poor Learners					Good Learners					Total				
	Male (N=5)		Female (N=5)			Male (N=5)		Female (N=5)			Poor Lrnrs. (N=10)		Good Lrnrs. (N=10)		
	Mean	S.D.	Mean	S.D.	"t"	Mean	S.D.	Mean	S.D.	"t"	Mean	S.D.	Mean	S.D.	"t"
Form A															
Words	34.4	7.50	59.0	12.30	3.41**	85.6	9.22	83.4	5.28	.41	46.7	15.97	84.5	7.59	6.41**
Phrases	26.0	8.00	32.0	7.48	1.10	76.0	12.00	74.0	10.20	.25	29.0	8.31	75.0	11.18	9.91**
Sentences	25.0	7.35	39.0	10.20	2.39*	77.0	12.88	77.0	12.08	.00	33.5	11.63	77.0	12.49	8.00**
Phrases & Sentences	24.6	4.92	36.4	5.50	3.20*	76.6	11.22	76.0	11.10	.08	30.5	7.88	76.3	11.16	10.06**
Form B															
Words	26.6	4.59	64.2	12.46	5.66**	83.4	5.61	87.6	9.18	.78	45.4	21.02	85.5	7.89	6.41**
Phrases	20.0	6.32	36.0	19.60	1.55	68.0	17.20	62.0	25.61	.39	28.0	16.61	65.0	22.02	4.02**
Sentences	24.0	9.16	31.0	5.83	1.29	62.0	13.27	64.0	14.97	.20	27.5	8.44	63.0	14.18	6.45**
Phrases & Sentences	22.8	4.87	32.8	6.58	2.44*	64.0	14.11	63.20	18.57	.07	27.8	7.65	63.6	16.50	5.90**
Form C															
Words	35.0	8.67	66.0	16.06	3.40**	86.8	7.63	83.2	9.52	.59	50.5	20.17	85.0	8.81	4.70**
Phrases	20.0	14.14	38.0	11.66	1.96	68.0	19.39	72.0	11.66	.35	29.0	15.78	70.0	16.12	5.45**
Sentences	28.0	8.72	38.0	4.00	2.08	58.0	19.90	66.0	15.30	.64	33.0	8.43	62.0	18.19	4.34**
Phrases & Sentences	25.4	9.39	38.0	5.22	2.34*	61.2	18.06	68.0	11.47	.64	31.7	9.87	64.6	15.51	5.37**
Total Battery															
Words	31.8	3.19	63.2	13.11	4.66**	84.8	5.60	85.0	7.40	.04	47.5	18.37	84.9	6.56	5.75**
Phrases	22.0	6.26	35.2	8.73	2.46*	70.8	12.59	69.4	13.46	.15	28.6	10.06	70.1	13.05	7.56**
Sentences	25.4	5.28	36.0	4.86	2.96*	65.6	14.65	69.0	12.85	.35	30.7	7.34	67.3	13.89	6.99**
Phrases & Sentences	24.2	4.40	35.6	5.08	3.39**	67.4	13.23	69.0	12.92	.17	29.9	7.42	68.2	13.10	7.63**

* for N = 10 $p \leq .05 = 2.31$

* for N = 20 $p \leq .05 = 2.10$
** for N = 10 $p \leq .01 = 3.36$

TABLE 12

PERCENTAGE CORRECT SCORES FOR SPEECHREADING BATTERY: EIGHT AND NINE YEAR OLDS

	Male (N=5)		Female (N=5)			Male (N=5)		Female (N=5)			Poor Lrnrs. (N=10)		Good Lrnrs. (N=10)		
	Mean	S.D.	Mean	S.D.	"t"	Mean	S.D.	Mean	S.D.	"t"	Mean	S.D.	Mean	S.D.	"t"
Form A															
Words	67.2	15.88	73.6	11.20	.66	93.2	5.78	93.6	.80	.14	70.4	14.12	93.4	4.13	4.69**
Phrases	50.0	28.98	70.0	20.00	1.14	90.0	12.65	90.0	6.32	.00	60.0	26.83	90.0	10.00	3.14**
Sentences	56.0	14.97	66.0	16.55	.90	92.0	7.48	91.0	7.35	.19	61.0	16.55	91.5	7.43	5.04**
Phrases & Sentences	54.0	18.32	67.4	16.07	1.10	91.4	8.69	90.8	6.52	.11	60.7	18.49	91.1	7.69	4.55**
Form B															
Words	75.4	7.66	73.8	16.55	.18	90.8	5.27	87.6	11.86	.49	74.6	12.92	89.2	9.32	2.75*
Phrases	36.0	21.54	54.0	22.45	1.16	80.0	8.94	68.0	9.80	1.81	45.0	23.77	74.0	11.14	3.31**
Sentences	49.0	22.67	54.0	13.93	.38	88.0	10.30	78.0	18.60	.94	51.5	18.98	83.0	15.84	3.82**
Phrases & Sentences	44.6	21.91	54.2	16.24	.70	85.4	8.26	74.4	13.41	1.40	49.4	19.88	79.9	12.42	3.90**
Form C															
Words	75.0	11.58	81.2	8.59	.86	92.8	5.11	87.2	8.73	1.11	78.1	10.65	90.0	7.68	2.72*
Phrases	38.0	7.48	62.0	14.70	2.91*	60.0	17.89	60.0	14.14	.00	50.0	16.73	60.0	16.12	1.29
Sentences	53.0	9.80	56.0	17.72	.30	93.0	5.10	63.0	20.88	2.79*	54.5	14.40	78.0	21.35	2.74*
Phrases & Sentences	48.2	7.36	58.0	15.47	1.14	82.0	8.67	62.0	17.98	2.00	53.1	13.06	72.0	17.30	2.62*
Total Battery															
Words	72.4	11.15	76.2	11.50	.47	92.2	3.37	89.6	6.50	.71	74.3	11.48	90.9	5.34	3.93**
Phrases	41.4	13.53	62.2	17.34	1.89	76.8	8.30	72.6	6.56	.79	51.8	18.71	74.7	7.77	3.39**
Sentences	52.6	13.81	58.4	14.09	.59	91.0	5.40	77.0	14.28	1.83	55.5	14.25	84.0	12.87	4.45**
Phrases & Sentences	49.0	13.80	59.0	15.09	1.06	86.2	5.67	75.8	11.39	1.63	54.4	15.44	81.0	10.49	4.29**

* for N = 10 $p \leq .05 = 2.31$

* for N = 20 $p \leq .05 = 2.10$
** for N = 20 $p \leq .01 = 2.68$

TABLE 13

SPEECHREADING PERCENTAGE CORRECT SCORES BY AGE: 4 & 5 YEAR AND 6 & 7 YEAR POOR LEARNERS

	4 & 5 yrs. (N=10)		6 & 7 yrs. (N=10)		
	Mean	S.D.	Mean	S.D.	"t"
Form A Slow Presentation					
Words	27.2	16.26	46.7	15.97	2.50*
Phrases	32.0	20.88	29.0	8.31	1.09
Sentences	25.0	16.12	33.5	11.63	1.83
Total Form A	27.4	14.79	39.3	11.55	1.90
Form B Normal Conversational Speed for Deaf					
Words	27.9	8.83	45.4	21.02	2.32*
Phrases	22.0	18.33	28.0	16.61	.73
Sentences	24.5	12.54	27.5	8.44	.60
Total Form B	25.8	8.57	37.5	14.28	2.11*
Form C Normal Conversational Speed for Hearing					
Words	31.6	17.31	50.5	20.17	2.11*
Phrases	24.0	18.00	29.0	15.78	.63
Sentences	28.0	13.82	33.0	8.43	.93
Total Form C	29.3	14.48	42.0	13.98	2.16*
Total Battery					
Words	28.9	12.70	47.5	18.37	2.50*
Phrases	26.2	14.79	28.6	10.06	.41
Sentences	25.9	12.29	30.7	7.34	1.00
Total Forms	27.5	11.84	39.3	12.96	1.38

* $p \leq .05 = 2.10$

TABLE 14

SPEECHREADING PERCENTAGE CORRECT SCORES BY AGE: 6 & 7 YEAR AND 8 & 9 YEAR POOR LEARNERS

	6 & 7 yrs. (N=10)		8 & 9 yrs. (N=10)		
	Mean	S.D.	Mean	S.D.	"t"
Form A					
Slow Presentation					
Words	46.7	15.97	70.4	14.12	4.71**
Phrases	29.0	8.31	60.0	26.83	3.31*
Sentences	33.5	11.63	61.0	16.55	4.08*
Total Form A	39.3	11.55	66.0	15.41	4.16**
Form B					
Normal Conversational Speed for Deaf					
Words	45.4	21.02	74.6	12.92	3.55*
Phrases	28.0	16.61	45.0	23.77	1.76
Sentences	27.5	8.44	51.5	18.98	3.44*
Total Form B	37.5	14.28	63.3	14.18	3.84**
Form C					
Normal Conversational Speed for Hearing					
Words	50.5	20.17	78.1	10.65	3.65**
Phrases	29.0	15.78	50.0	16.73	3.14**
Sentences	33.0	8.43	54.5	14.40	3.87**
Total Form C	42.0	13.98	66.7	10.88	5.20**
Total Battery					
Words	47.5	18.37	74.3	11.48	3.56**
Phrases	28.6	10.06	51.8	18.71	3.28**
Sentences	30.7	7.34	55.5	14.25	4.64**
Total Forms	39.3	12.96	65.2	12.78	5.11**

*$p \leq .05 = 2.01$
**$p \leq .01 = 2.88$

TABLE 15

SPEECHREADING PERCENTAGE CORRECT SCORES BY AGE:
4 & 5 YEAR AND 6 & 7 YEAR GOOD LEARNERS

	4 & 5 yrs.		6 & 7 yrs.		
	(N=10)		(N=10)		
	Mean	S.D.	Mean	S.D.	"t"
Form A Slow Presentation					
Words	53.3	17.27	84.5	7.59	4.96**
Phrases	50.0	16.73	75.0	11.18	3.73**
Sentences	41.0	17.72	77.0	12.49	4.98**
Total Form A	49.0	15.08	80.7	8.73	5.46**
Form B Normal Conversational Speed for Deaf					
Words	51.8	18.23	85.5	7.89	5.09*
Phrases	35.0	13.60	65.0	22.02	3.48*
Sentences	38.5	21.57	63.0	14.18	2.85*
Total Form B	45.2	16.12	75.5	10.67	4.52**
Form C Normal Conversational Speed for Hearing					
Words	55.0	18.24	85.0	8.81	4.44**
Phrases	42.0	17.78	70.0	16.12	3.50**
Sentences	40.5	14.74	62.0	18.19	2.76*
Total Form C	48.2	15.52	75.7	10.05	4.46**
Total Battery					
Words	28.9	12.70	47.5	18.37	2.50*
Phrases	26.2	14.79	28.6	10.06	.41
Sentences	39.7	17.14	67.3	13.89	3.76**
Total Forms	47.4	15.24	77.3	9.10	7.20**

*p≤.05 = 2.10
**p≤.01 = 2.88

TABLE 16

SPEECHREADING PERCENTAGE CORRECT SCORES BY AGE: 6 & 7 YEAR AND 8 & 9 YEAR GOOD LEARNERS

	6 & 7 yrs. (N=10)		8 & 9 yrs. (N=10)		
	Mean	S.D.	Mean	S.D.	"t"
Form A Slow Presentation					
Words	84.5	7.59	93.4	4.13	3.23**
Phrases	75.0	11.18	90.0	10.00	3.00**
Sentences	77.0	12.49	91.5	7.43	2.99**
Total Form A	80.7	8.73	92.2	4.87	3.45**
Form B Normal Conversational Speed for Deaf					
Words	85.5	7.89	89.2	9.32	.91
Phrases	65.0	22.02	74.0	11.14	1.09
Sentences	63.0	14.18	83.0	15.84	2.82*
Total Form B	75.5	10.67	84.9	9.42	1.98
Form C Normal Conversational Speed for Hearing					
Words	85.0	8.81	90.0	7.68	1.29
Phrases	70.0	16.12	60.0	16.12	1.32
Sentences	62.0	18.19	78.0	21.35	1.71
Total Form C	75.7	10.05	81.6	11.44	1.45
Total Battery					
Words	47.5	18.37	74.3	11.48	3.56**
Phrases	28.6	10.06	51.8	18.71	3.28**
Sentences	67.3	13.89	84.0	12.87	2.65*
Total Forms	77.3	9.10	86.1	7.09	4.29**

*$p \leq .05 = 2.10$
**$p \leq .01 = 2.88$

TABLE 17

SPEECHREADING PERCENTAGE CORRECT SCORES BY AGE: 6 & 7 YEAR POOR LEARNERS AND 4 & 5 YEAR GOOD LEARNERS

	6 & 7 Year Poor Lrnrs.(N=10)		4 & 5 Year Good Lrnrs. (N=10)		
	Mean	SD	Mean	SD	"t"
Form A					
Words	46.7	15.97	53.3	17.27	.84
Phrases	29.0	8.31	50.0	16.73	3.35**
Sentences	33.5	11.63	41.0	17.72	1.11
Total Form A	39.3	11.55	49.0	15.08	1.37
Form B					
Words	45.4	21.02	51.8	18.23	.70
Phrases	28.0	16.61	35.0	13.60	.98
Sentences	27.5	8.44	38.5	21.57	1.42
Total Form B	37.5	14.28	45.2	16.12	1.07
Form C					
Words	50.5	20.17	55.0	18.24	.51
Phrases	29.0	15.78	42.0	17.78	1.68
Sentences	33.0	8.43	40.5	14.74	1.32
Total Form C	42.0	13.98	48.2	15.52	.89
Total Battery					
Words	47.5	18.37	53.5	16.74	.71
Phrases	28.6	10.06	42.3	12.69	2.54*
Sentences	30.7	7.34	39.7	17.14	1.43
Total	39.3	12.96	47.4	15.24	1.21

*p≤.05 = 2.10
**p≤.01 = 2.88

TABLE 18

SPEECHREADING PERCENTAGE CORRECT SCORES BY AGE:
8 & 9 YEAR POOR LEARNERS AND 4 & 5 YEAR GOOD LEARNERS

	8 & 9 Year Poor Lrnrs.(N=10)		4 & 5 Year Good Lrnrs.(N=10)		
	Mean	S.D.	Mean	S.D.	"t"
Form A					
Words	70.4	14.12	53.3	17.27	2.29*
Phrases	60.0	26.83	50.0	16.73	.94
Sentences	61.0	16.55	41.0	17.72	2.47*
Total Form A	66.0	15.41	49.0	15.08	2.36*
Form B					
Words	74.6	12.92	51.8	18.23	3.06**
Phrases	45.0	23.77	35.0	13.60	2.29*
Sentences	51.5	18.98	38.5	21.57	1.36
Total Form B	63.3	14.18	45.2	16.12	3.84**
Form C					
Words	78.1	10.65	55.0	18.24	3.28**
Phrases	50.0	16.73	42.0	17.78	.98
Sentences	54.5	14.40	40.5	14.74	2.05
Total Form C	66.7	10.88	48.2	15.52	2.92**
Total Battery					
Words	74.3	11.48	53.5	16.74	2.91**
Phrases	51.8	18.71	42.3	12.69	1.25
Sentences	55.5	14.25	39.7	17.14	2.14*
Total	65.2	12.78	47.4	15.24	2.68*

*$p \leq .05$ = 2.10
**$p \leq .01$ = 2.88

TABLE 19

SPEECHREADING PERCENTAGE CORRECT SCORES BY AGE: 8 & 9 YEAR POOR LEARNERS AND 6 & 7 YEAR GOOD LEARNERS

	8 & 9 Year Poor Lrnrs. (N=10)		6 & 7 Year Good Lrnrs. (N=10)		
	Mean	S.D.	Mean	S.D.	"t"
Form A					
Words	70.4	14.12	84.5	7.59	2.74*
Phrases	60.0	26.83	75.0	11.18	1.56
Sentences	61.0	16.55	77.0	12.49	2.41*
Total Form A	66.0	15.41	80.7	8.73	2.45*
Form B					
Words	74.6	12.92	85.5	7.89	2.18*
Phrases	45.0	23.77	65.0	22.02	1.82
Sentences	51.5	18.98	63.0	14.18	1.46
Total Form B	63.3	14.18	75.5	10.67	2.09
Form C					
Words	78.1	10.65	85.0	8.81	1.28
Phrases	50.0	16.73	70.0	16.12	2.59*
Sentences	54.5	14.40	62.0	18.19	.96
Total Form C	66.7	10.88	75.7	10.05	1.82
Total Battery					
Words	74.3	11.48	84.9	6.56	2.40*
Phrases	51.8	18.71	70.1	13.05	2.44*
Sentences	55.5	14.25	67.3	13.89	1.63
Total	65.2	12.78	77.3	9.10	2.30*

*$p \leq .05$ = 2.10
**$p \leq .01$ = 2.88

In contrast, for the Good Learners the most rapid period of growth was between five and seven years, with slight improvement continuing through the age of nine. At the ages of six and seven ability to speechread seems to have been fairly well established; moreover, they manifested definite indications of this ability at ages four and five. Between five and seven there was an improvement of 30 percent in most of the scores but between seven and nine words improved only 5 percent and phrases and sentences 17 percent.

It was noted that the six and seven year Poor Learners were similar to the younger age Good Learners, while the performance of the eight and nine year Poor Learners was most like that of the six and seven year Good Learners. It is interesting that the ability of the eight and nine year old Poor Learners to speechread sentences at the faster speeds was not much greater than that of the better four and five year old Good Learners. Generally the battery revealed the poor speechreaders, on the average, to be two years retarded in their lipreading abilities. On some measures, notably the capacity to deal with complex material at faster rates of speed, the Poor Learners were four years retarded.

Tables 20, 21, and 22 present the information which relates to effect of rate utterance and length and meaning of material. For the youngest Poor Learners none of the "F" ratios reached significance; regardless of speed or length or meaning of the material these youngsters just were not capable of lipreading. The four and five year old Good Learners displayed a similar pattern in that speed had little effect on their abilities, although the ratio of words to phrases and sentences seemed somewhat altered by the faster speed of Form C.

The six and seven year Poor Learners demonstrated ability to speechread about 50 percent of the words regardless of the speed of presentation. In fact, in none of the groups was speed a factor in speechreading single words. Regardless of the rate of utterance, in general, the six and seven year old Poor Learning children were unable to speechread phrases and sentences. Speed was of moderate influence on the six and seven year old Good Learners; sentences were more easily recognized at the slower speed. At each rate the subjects performed significantly better on words.

At the oldest age levels ability to speechread words remained unchanged despite increase in speed. Although for both the Good and Poor Learners there was a tendency for sentence scores to decrease as speed increased the differences were not significant. For the entire sample the slowest speed (Form A) was most suitable; the subjects were able to read words, phrases, and sentences with equal facility. However, as speed increased the ratio of correct responses on the more complex material to responses on words decreased. As normal conversational speeds were approached there were definite effects on recognition and understanding of sentences and phrases for both the good and poor speechreaders. It appears that the optimum speed is that which is one-third slower than the somewhat slower rate that customarily is used when addressing the deaf.

Further analysis was undertaken through recording performance on words, phrases, and sentences of different lengths (Tables 23 and 24).

TABLE 20

SPEECHREADING PERCENTAGE CORRECT SCORES BY SPEED OF PRESENTATION AND TYPE OF STIMULI: FOUR AND FIVE YEAR OLDS

	Form A		Form B		Form C			Total Battery	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	F Ratio	Mean	S.D.
Poor Learners (N=10)									
Words	27.2	16.26	27.9	8.83	31.6	17.31	.69	28.9	12.70
Phrases	32.0	20.88	22.0	18.33	24.0	18.00	1.15	26.2	14.79
Sentences	25.0	16.12	24.5	12.54	28.0	13.82	.42	25.9	12.29
	F Ratio	.74	F Ratio	.56	F Ratio	1.09		F Ratio	.62
Good Learners (N=10)									
Words	53.3	17.27	51.8	18.23	55.0	18.24	.41	53.5	16.74
Phrases	50.0	16.73	35.0	13.60	42.0	17.78	3.45	42.3	12.69
Sentences	41.0	17.72	38.5	21.57	40.5	14.74	.20	39.7	17.14
	F Ratio	2.99	F Ratio	2.99	F Ratio	4.74*		F Ratio	2.02

*p $\leq$ .05 = 3.44

TABLE 21

SPEECHREADING PERCENTAGE CORRECT SCORES BY SPEED OF PRESENTATION AND TYPE OF STIMULI: SIX AND SEVEN YEAR OLDS

	Form A		Form B		Form C			Total Battery	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	F Ratio	Mean	S.D.
Poor Learners (N=10)									
Words	46.7	15.97	45.4	21.02	50.5	20.17	1.10	47.5	18.37
Phrases	29.0	8.31	28.0	16.61	29.0	15.78	.02	28.6	10.06
Sentences	33.5	11.63	27.5	8.44	33.0	8.43	1.26	29.9	7.42
	F Ratio 7.82**		F Ratio 5.78*		F Ratio 8.95**			F Ratio 5.86*	
Good Learners (N=10)									
Words	84.5	7.59	85.5	7.89	85.0	8.81	.06	84.9	6.56
Phrases	75.0	11.18	65.0	22.02	70.0	16.12	1.26	70.1	13.05
Sentences	77.0	12.49	63.0	14.18	62.0	18.19	10.61**	67.3	13.89
	F Ratio 7.01**		F Ratio 14.38**		F Ratio 8.82**			F Ratio 5.80*	

*p ≤ .05 = 3.44
**p ≤ .01 = 6.03

TABLE 22

SPEECHREADING PERCENTAGE CORRECT SCORES BY SPEED OF PRESENTATION AND TYPE OF STIMULI: EIGHT AND NINE YEAR OLDS

	Form A		Form B		Form C			Total Battery	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	F Ratio	Mean	S.D.
Poor Learners (N=10)									
Words	70.4	14.12	74.6	12.92	78.1	10.65	2.69	74.3	11.48
Phrases	60.0	26.83	45.0	23.77	50.0	16.73	2.03	51.8	18.71
Sentences	61.0	16.55	51.5	18.98	54.5	14.40	1.93	55.5	14.25
	F Ratio	2.25	F Ratio	15.98**	F Ratio	21.41**		F Ratio	5.50*
Good Learners (N=10)									
Words	93.4	4.13	89.2	9.32	90.0	7.68	1.21	90.9	5.34
Phrases	90.0	10.00	74.0	11.14	60.0	16.12	13.40**	74.7	7.77
Sentences	91.5	7.43	83.0	15.84	78.0	21.35	3.08	84.0	12.87
	F Ratio	.88	F Ratio	5.33*	F Ratio	14.48**		F Ratio	5.75*

*p $\leq .05 = 3.44$
**p $\leq .01 = 6.03$

TABLE 23

SPEECHREADING PERCENTAGE CORRECT SCORES BY
LENGTH OF UTTERANCE: WORDS

	4 & 5 years				6 & 7 years				8 & 9 years			
	Poor Lrnrs. (N=10)		Good Lrnrs. (N=10)		Poor Lrnrs. (N=10)		Good Lrnrs. (N=10)		Poor Lrnrs. (N=10)		Good Lrnrs. (N=10)	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Form A												
1 Syllable	27.8	17.27	56.1	23.52	44.4	21.60	88.2	6.61	79.8	15.75	90.5	7.88
2 Syllable	21.0	22.35	35.8	22.52	45.5	23.90	84.6	15.73	66.6	24.77	93.4	10.62
3 Syllable	21.8	17.58	51.8	17.40	49.9	9.63	84.9	16.55	68.3	22.84	98.3	5.38
4 Syllable	33.3	41.60	40.0	34.52	36.6	4.31	59.9	37.95	63.4	24.76	93.4	13.91
Form B												
1 Syllable	29.4	12.23	54.3	21.90	49.0	28.06	89.2	8.38	78.2	16.72	89.4	14.06
2 Syllable	25.3	10.44	49.9	21.99	37.6	24.79	84.6	12.91	80.1	18.03	95.7	9.06
3 Syllable	23.4	17.82	66.7	19.24	50.1	24.82	94.9	8.21	71.7	20.85	94.9	8.21
4 Syllable	9.9	15.94	16.7	31.30	33.4	31.58	56.8	27.59	46.6	28.28	86.8	17.04
Form C												
1 Syllable	37.8	21.16	60.5	17.04	52.3	22.33	86.6	10.24	81.5	11.21	90.9	9.21
2 Syllable	28.7	22.36	55.4	29.34	51.1	25.42	84.6	10.62	80.2	10.11	94.5	7.18
3 Syllable	23.4	25.12	53.3	23.23	51.5	24.04	88.2	19.26	74.9	25.22	88.2	11.26
4 Syllable	19.9	23.30	19.9	23.30	36.6	24.76	70.1	24.68	56.7	22.74	73.3	37.92

TABLE 24

SPEECHREADING PERCENTAGE CORRECT SCORES BY
LENGTH OF UTTERANCE: PHRASES AND SENTENCES

	4 & 5 years				6 & 7 years				8 & 9 years			
	Poor Lrnrs. (N=10)		Good Lrnrs. (N=10)		Poor Lrnrs. (N=10)		Good Lrnrs. (N=10)		Poor Lrnrs. (N=10)		Good Lrnrs. (N=10)	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Phrases												
Form A	25.0	22.24	50.0	12.64	28.0	8.76	75.0	11.58	60.0	28.88	90.5	10.21
Form B	23.0	24.81	35.0	14.34	28.0	17.51	65.0	22.73	45.0	25.06	68.0	11.74
Form C	24.0	18.97	42.0	18.74	29.0	16.63	74.0	9.66	50.0	17.64	60.0	17.00
Sentences												
Form A												
3 to 5 Words	28.4	34.29	51.7	26.70	40.1	24.99	81.8	16.40	61.6	22.33	91.6	11.78
6 to 8 Words	18.4	19.91	41.7	25.07	25.0	17.90	73.3	20.95	60.0	16.10	88.3	17.63
9 to 12 Words	17.5	18.97	32.5	19.79	30.1	12.38	76.3	19.33	61.2	28.87	93.8	10.59
Form B												
3 to 5 Words	15.0	14.47	33.3	23.41	24.9	16.06	60.0	21.17	56.6	26.24	85.0	18.28
6 to 8 Words	30.0	20.43	46.7	25.63	36.7	17.70	65.1	12.21	51.7	25.54	76.7	27.32
9 to 12 Words	22.4	22.01	36.1	28.68	22.5	16.62	68.9	24.54	47.5	23.31	86.3	18.20
Form C												
3 to 5 Words	38.3	24.84	43.4	17.94	36.7	15.19	61.7	24.89	51.7	24.25	80.0	20.43
6 to 8 Words	23.4	26.16	35.1	21.41	33.5	17.39	55.0	29.37	49.9	22.17	71.6	32.43
9 to 12 Words	31.4	22.29	39.2	22.57	30.1	12.38	67.5	17.79	60.1	24.11	81.4	23.00

The youngest children had most difficulty with four syllable words when presented at the faster speeds; this was true also for the older Poor Learners. However, the number of four syllable words in the battery was small so that interpretation must be limited. Sentences ranged in length from three to twelve words with only two of each length being presented at a time. The 24 sentences were divided into three groups: those three to five words long; those six to eight; and those nine through twelve. Examination revealed no trends, the subjects performing equally well on the longer sentences at faster speed and the shorter ones at slower speeds. The most consistent observation that could be made was that again the slowest speeds were the easier for all of the Poor Learners and for the Good Learners in the two younger age groups.

INTELLIGENCE

The results of the Hiskey-Nebraska Test of Learning Aptitude are presented in Tables 25 and 26. Comparison of raw scores and quotients produced no specific pattern of differences within the age groups. In the youngest group significant differences were observed on the Bead Pattern, Picture Association, and Visual Attention Span sub-tests; for six and seven year olds it was Memory for Color Picture Association, Block Patterns and Completion of Drawings; for the oldest group the only significant difference observed was in Paper Folding. When the Hiskey Learning Quotient was computed (derived from the Median Learning Age) the Good Learners scored significantly higher in each of the age groupings despite the lack of consistent superiority in the sub-test scores ($p \leq .01$). It is interesting to observe that when the sub-test results are presented in quotient form for all of the subjects the data reveal the superiority of the better speechreaders on all test items. Further, the Mean Learning Quotient of the Good Learners, 109.2, was 16 points higher than that of the Poor Learners, a difference significant beyond the one percent level.

In Table 27 the sub-test scores are ranked, producing a rather interesting pattern. For both the Poor Learners and Good Learners Completion of Drawings and Block Patterns showed the highest quotient scores. The score for the Poor Learners for Completion of Drawings was significantly higher than all other sub-tests except for Block Patterns; similarly Block Patterns were found to be superior to Paper Folding, Memory for Color, and Visual Attention Span. In the Poor Learner group the best performance was on items emphasizing visual perception with poorer scores on tests requiring certain forms of memory. For the Good Learners, Completion of Drawings scores were significantly different from Picture Association, Memory for Color, Bead Patterns and Picture Identification; Block Patterns also differed from Bead Patterns, Memory for Color and Picture Association. Although the Good Learners, like the Poor Learners, scored highest on the visual perceptual items there was little difference among the other sub-tests.

Preliminary analysis of intellectual functioning based on the Hiskey suggested a pattern of difference; the Good Learners not only had higher Learning Quotients but their sub-test scores all were above average; for the Poor Learners only two scores could be considered either average or above average. A question to be answered, therefore, was

TABLE 25

MEAN HISKEY-NEBRASKA RAW SCORES FOR POOR AND GOOD LEARNERS

	Poor Learners			Good Learners				Expected
	N	Mean	S.D.	N	Mean	S.D.	"t"	Score
4 & 5 years	10			10				
Bead Patterns		7.3	1.74		8.7	1.10	2.04	7.5
Memory for Color		9.0	1.84		10.4	1.36	1.83	9.5
Picture Ident.		12.4	2.42		14.9	1.51	2.63*	12.5
Picture Association		4.9	1.81		5.4	1.74	.59	5.3
Paper Folding		3.7	1.10		4.5	1.20	1.47	3.5
Visual Attn. Span		3.9	1.81		6.0	1.55	2.64*	4.3
Block Pattern		2.8	1.54		3.3	.90	.84	2.3
Compltn. of Drawings		5.4	6.55		9.4	4.25	1.54	2.5
6 & 7 years	10			10				
Bead Patterns		10.1	.70		10.6	.66	1.56	10.3
Memory for Color		11.4	1.11		12.7	1.35	2.23*	12.5
Picture Ident.		16.2	1.54		16.9	1.52	.97	17.0
Picture Association		7.8	1.33		9.1	1.70	1.81	9.0
Paper Folding		5.3	1.35		6.2	1.17	1.52	6.2
Visual Attn. Span		5.9	1.51		6.6	1.36	1.03	7.3
Block Pattern		5.5	1.86		7.8	2.23	2.38*	5.0
Compltn. of Drawings		14.2	1.40		16.9	4.35	1.77	13.5
8 & 9 years	10			10				
Bead Patterns		10.9	.83		11.3	.78	1.05	11.2
Memory for Color		12.3	2.00		13.4	1.74	1.24	14.3
Picture Ident.		18.1	2.63		18.6	1.56	.49	19.0
Picture Association		10.8	1.94		11.2	.87	.56	11.3
Paper Folding		5.6	1.11		7.2	1.08	3.09**	7.0
Visual Attn. Span		6.6	1.43		6.4	1.69	.27	8.3
Block Pattern		9.1	2.84		11.4	4.43	1.31	9.0
Compltn. of Drawings		20.0	2.00		18.7	4.41	.81	18.0
Total	30			30				
Bead Patterns		9.4	1.94		10.2	1.40	1.72	10.3
Memory for Color		10.9	2.19		12.2	1.97	2.31*	12.4
Picture Ident.		15.6	3.26		16.8	2.15	1.69	16.8
Picture Association		7.8	2.96		8.5	2.83	.97	8.8
Paper Folding		4.9	1.45		5.9	1.60	2.73	6.2
Visual Attn. Span		5.5	1.96		6.3	1.56	1.86	7.3
Block Pattern		5.8	3.36		7.5	4.41	1.65	4.8
Compltn. of Drawings		13.2	7.23		15.0	5.92	1.04	12.8

* for N = 60 $p \leq .05 = 2.01$
* for N = 20 $p \leq .05 = 2.10$
** for N = 20 $p \leq .01 = 2.88$

TABLE 26

MEAN HISKEY-NEBRASKA QUOTIENT SCORES FOR POOR AND GOOD LEARNERS

	Poor Learners			Good Learners			
	N	Mean	S.D.	N	Mean	S.D.	"t"
4 & 5 years	10			10			
Bead Patterns		97.5	12.91		117.2	13.66	3.15**
Memory for Color		95.6	20.07		115.6	22.71	1.98
Picture Identification		100.7	16.82		125.2	31.30	2.07
Picture Association		95.9	18.81		107.0	26.87	1.02
Paper Folding		98.6	14.26		115.0	23.68	1.78
Visual Att'n Span		96.6	21.47		130.8	29.71	2.80*
Block Patterns		97.5	23.13		114.7	22.37	1.60
Completion of Drawings		107.3	30.08		129.2	12.12	2.03
Learning Quotient		96.7	10.98		117.1	13.44	3.54**
6 & 7 years	10			10			
Bead Patterns		95.1	13.35		108.5	17.07	1.85
Memory for Color		84.5	13.32		104.1	14.05	3.04**
Picture Identification		92.2	16.64		104.2	18.27	1.45
Picture Association		90.2	9.98		102.1	8.74	2.85**
Paper Folding		90.2	30.14		107.9	24.80	1.36
Visual Att'n Span		83.2	13.23		94.8	16.74	1.63
Block Patterns		97.5	16.31		123.6	22.95	2.78
Completion of Drawings		102.8	5.99		133.9	43.92	2.10*
Learning Quotient		91.2	10.42		106.5	9.75	3.22**
8 & 9 years	10			10			
Bead Patterns		88.6	17.40		102.3	17.81	1.66
Memory for Color		77.0	24.05		92.6	18.28	1.55
Picture Identification		95.0	25.24		102.9	23.31	.70
Picture Association		97.1	17.84		102.4	13.17	.72
Paper Folding		72.2	16.51		110.8	28.54	3.51**
Visual Att'n Span		72.8	16.19		75.7	19.74	.34
Block Patterns		102.0	20.40		123.8	30.66	1.77
Completion of Drawings		115.3	16.15		118.3	31.98	.25
Learning Quotient		89.8	7.65		104.1	10.98	3.20**
Total	30			30			
Bead Patterns		93.7	15.17		109.3	17.39	3.64**
Memory for Color		85.7	21.10		104.1	20.91	3.34**
Picture Identification		95.9	20.28		110.8	26.89	2.37*
Picture Association		94.4	16.32		104.1	18.12	2.14*
Paper Folding		86.9	24.14		111.2	25.92	3.68**
Visual Att'n Span		84.9	19.86		111.2	32.23	2.31*
Block Patterns		99.0	20.26		120.7	25.95	3.55**
Completion of Drawings		108.5	20.66		127.1	32.79	2.59*
Learning Quotient		92.6	10.23		109.2	12.82	5.48**

* for N = 60 $p \leq .05 = 2.01$
* for N = 20 $p \leq .05 = 2.10$
** for N = 20 $p \leq .01 = 2.88$

TABLE 27

RANK ORDER OF HISKEY SUB-TESTS FOR BOTH THE POOR AND GOOD LEARNERS

Poor Learners		Good Learners	
Sub-Test	Quotient	Sub-Test	Quotient
Completion of Drawing	108.5	Completion of Drawing	127.1
Block Patterns	99.0	Block Patterns	120.7
Picture Identification	95.9	Paper Folding	111.2
Picture Association	94.4	Visual Att'n Span	111.2
Bead Patterns	93.7	Picture Identification	110.8
Paper Folding	86.9	Bead Patterns	109.3
Memory for Color	85.7	Memory for Color	104.1
Visual Att'n Span	84.9	Picture Association	104.1

whether those classified as poor speechreaders were truly inferior intellectually, or does the Hiskey sample those mental abilities more directly related to speechreading. To pursue these questions the data concerning the Good and Poor Speechreaders in our previous study (Bell) and additional information on the present subject population was reviewed.

In the Bell Study the Wechsler Intelligence Scale for Children (WISC) was one of the measures of intelligence employed with those children five years and above. Table 28 presents these data. The results are not clear; the only age level showing a significant difference was at six and seven, but when the total groups were considered there was a significant difference, the better speechreaders being superior.

In analyzing the Hiskey data our concern was that through the subject selection process we had chosen as poor lipreaders those who were basically intellectually inferior, although no restriction other than an IQ greater than 80 was required. Previous psychological test information was available for 33 of the subjects; of the 17 Good Learners for whom data were reported seven were tested with the Leiter International and ten with the WISC. Of the 16 Poor Learners, ten were tested with the Leiter and six with the WISC. Except for the younger Poor Learners, the pretest IQ's were significantly higher; for the six and seven year Poor Learners the trend was in the same direction. In the Poor Learner group, 13 had lower scores on the Hiskey, one scored higher, and for two there was no difference; the mean differences ranged from six to eleven points. With the Good Learners 14 demonstrated higher scores on the WISC and Leiter with three achieving better results on the Hiskey. The mean difference between the two IQ's was about 20 points (see Table 29).

It may be that the Hiskey-Nebraska Test samples aspects of intellectual functioning that are different from those measured by the WISC and Leiter. In fact, the Hiskey may more accurately reflect the deaf child's capacity for verbal learning and thus more directly indicate speechreading potential. Of those subjects having Learning Quotients of 94 or less ($n = 25$), 21 (or 84 percent) were Poor Learners. The probability of such a relationship occurring by chance is .001. Of the 28 children achieving Learning Quotients of 100 or higher, 21 (or 75 percent) were Good Learners ($p \leq .001$). Seven subjects, five Good Learners and two Poor Learners had scores between 95 and 99. It would appear that the lower the Hiskey Quotient the poorer the chances of the deaf child being a good speechreader, to the point that when the score is 94 or below the chances of this level of ability occurring are less than one in five. On the other hand, with a Learning Quotient of 100 the chances of becoming a good speechreader are three out of four.

VISUAL PERCEPTION

To explore possible specific associations between visual perceptual behavior and speechreading a series of special tests and measures were incorporated. These included the Knox Cube Test, the Kohs Block Design Test, the Ontario Tapping Test, and the Tachistoscopic procedures developed by Myklebust and Brutten (1953).

TABLE 28

RESULTS FOR GOOD AND POOR SPEECHREADERS FOR WISC IQ - BELL STUDY

	Good Speechreaders			Poor Speechreaders			
	N	Mean	S.D.	N	Mean	S.D.	"t"
5 years	9	107.6	12.67	3	104.0	6.08	.58
6 & 7 years	9	107.0	10.07	15	95.1	12.93	2.40*
8 & 9 years	6	101.7	8.52	7	99.0	16.22	.35
Total	24	105.9	9.74	25	97.2	13.26	2.59*

* for N = 50 $p \leq .05 = 2.02$
* for N = 25 $p \leq .05 = 2.07$

TABLE 29

RESULTS COMPARING THE PRETEST INTELLIGENCE QUOTIENTS AND THE HISKEY LEARNING QUOTIENTS

	Poor Learners						Good Learners					
	Pretest			Hiskey			Pretest			Hiskey		
	N	Mean	S.D.	Mean	S.D.	"t"	N	Mean	S.D.	Mean	S.D.	"t"
6 & 7 years	8	101.1	15.90	93.9	11.16	1.05	8	127.5	14.8	104.8	10.89	3.33**
8 & 9 years	8	100.4	11.76	89.8	9.22	5.09**	9	118.2	14.9	102.4	10.78	5.29**

**p $\leq$ .01 = 2.99

The results of the Knox Cube Test are presented in Table 30. These findings reveal no significant differences at the younger ages but at eight and nine years the Good Learners were superior ("t" = 2.74, p = .05). The test may have been too difficult for the youngest Poor Learners, but the large standard deviations suggest wide difference of ability and made meaningful comparisons difficult even when the total sample was considered. An interesting development was that the Poor Learners, except for the youngest, achieved quotient scores which were in the normal range; on the other hand, the scores for the Good Learners were in the superior range. (Myklebust (1964) and Blair (1957) have reported similar observations for the Knox Cubes.) We might conclude that at least average ability of this type must be demonstrated by the deaf if they are to maintain a homeostatic balance with their environment. Also, that those who are good speechreaders usually display superior ability in this respect. The Ontario Tapping Test samples similar behavior so it was not unexpected that the same pattern of results was observed for both Poor and Good Learners. These results are presented in Table 31.

The results of the Kohs Block Design Test are presented in Table 32. As only three subjects from the youngest Good and Poor Learners age groups were able to achieve measurable scores the Table reflects only the results obtained at the older age levels. At each of the age levels there was a trend for the Good Learners to attain better scores although the differences were not statistically significant; when the total groups were compared the difference became significant ("t" = 3.07, $p \leq .01$). As was noted, with the Knox Cube and the Tapping Tests, the Poor Learners' scores fell in the average range while the Good Learners' were superior.

The results of the various Tachistoscopic tests are presented in Tables 33 to 36. No significant differences were observed except for the eight and nine year olds for Pattern Reproduction but again the trend throughout was for the Good Learners to have higher scores.

On the more simple perceptual tasks the results suggest that there was little difference in the behavior of the subjects. However, on the more difficult tasks, requiring sequential memory or more complicated discriminations, the Poor Learners demonstrated ability considered average while the Good Learners were superior; a superiority which they demonstrated throughout.

EDUCATIONAL ACHIEVEMENT

The Metropolitan Achievement Tests, Primary Battery, and the Picture Story Language Test were administered to all subjects six years of age or older. These results for the reading section are presented in Table 37. For all of the subjects, the Good Learners, the better speechreaders, performed significantly better on reading vocabulary; this relationship was previously observed by Myklebust (1964) and it was demonstrated in our Bell School study (Neyhus, 1967). No significant differences were found for reading comprehension although the scores for the eight and nine year old Good Learners were higher by two-thirds of a grade. At six and seven years the retardation of the total sample appeared minimal but at this early age all children are just beginning to read and the deaf develop competancy at the word naming level. Among the older subjects

TABLE 30

THE KNOX CUBE QUOTIENT SCORES BY GROUP

	Poor Learners			Good Learners			
	N	Mean	S.D.	N	Mean	S.D.	"t"
4 & 5 yrs.	10	78.23	28.94	10	97.26	11.33	1.55
6 & 7 yrs.	10	124.51	59.39	10	170.92	41.71	1.92
8 & 9 yrs.	10	117.59	45.31	10	159.33	32.02	2.26*
Total	30	106.78	50.54	30	141.50	45.86	2.74*

* for N = 60 $p \leq .05 = 2.01$
* for N = 20 $p \leq .05 = 2.10$

TABLE 31

TAPPING TEST QUOTIENT SCORES BY GROUP

	Poor Learners			Good Learners			
	N	Mean	S.D.	N	Mean	S.D.	"t"
4 & 5 yrs.	10	99.9	45.90	10	133.3	31.11	1.80
6 & 7 yrs.	10	91.5	52.65	10	132.2	27.78	2.13*
8 & 9 yrs.	10	114.0	19.46	10	136.8	26.38	2.09*
Total	30	101.8	42.64	30	134.1	27.33	3.43*

* for N = 60 $p \leq .05 = 2.01$
* for N = 20 $p \leq .05 = 2.10$

TABLE 32

KOHS BLOCK DESIGN QUOTIENT SCORES BY GROUP

	Poor Learners			Good Learners			
	N	Mean	S.D.	N	Mean	S.D.	"t"
6 & 7 years	10	96.3	16.61	10	111.4	24.68	1.63
8 & 9 years	10	101.9	26.56	10	122.1	39.26	1.65
Total	20	99.1	23.45	20	128.7	36.95	3.02**

**$p \leq .01 = 2.72$

TABLE 33

PATTERN REPRODUCTION SCORES BY GROUP

	Poor Learners			Good Learners			
	N	Mean	S.D.	N	Mean	S.D.	"t"
4 & 5 years	10	17.50	9.14	10	20.80	7.59	.83
6 & 7 years	10	27.90	9.21	10	33.90	4.97	1.72
8 & 9 years	10	34.10	6.88	10	39.00	1.00	2.12*

$p \leq .05 = 2.10$

TABLE 34

DOT REPRODUCTION SCORES BY GROUP

	Poor Learners			Good Learners			"t"
	N	Mean	S.D.	N	Mean	S.D.	
4 & 5 years	10	10.30	7.21	10	13.10	7.16	.83
6 & 7 years	10	23.10	11.48	10	31.40	6.17	1.91
8 & 9 years	10	33.10	9.24	10	37.50	1.75	1.40

p ≤ .05 = 2.10

TABLE 35

TOTAL REPRODUCTION RAW SCORES BY GROUP

	Poor Learners			Good Learners			"t"
	N	Mean	S.D.	N	Mean	S.D.	
4 & 5 years	10	27.80	14.08	10	33.90	12.93	.96
6 & 7 years	10	51.00	18.66	10	65.30	8.68	2.08
8 & 9 years	10	66.50	16.10	10	76.50	2.06	1.85

p ≤ .05 = 2.10

TABLE 36

FIGURE RESPONSES IN FIGURE GROUND TEST SCORES BY GROUPS

	Poor Learners			Good Learners			
	N	Mean	S.D.	N	Mean	S.D.	"t"
4 & 5 years	10	4.90	3.02	10	4.00	1.41	.81
6 & 7 years	10	4.50	2.11	10	6.00	2.05	1.53
8 & 9 years	10	5.90	2.34	10	6.10	2.74	.17

$p \leq .05 = 2.10$

TABLE 37

METROPOLITAN READING GRADE SCORES BY GROUP

		Word Knowledge							Reading Comprehension						
		Poor Learners			Good Learners				Poor Learners			Good Learners			
	N	Mean	S.D.	Ex.Grd.	Mean	S.D.	Ex.Grd.	"t"	Mean	S.D.	Ex.Grd.	Mean	S.D.	Ex.Grd.	"t"
6 & 7 yrs.	10	1.50	.21	1.9	2.03	.50	1.7	2.90**	1.49	.28	1.9	1.60	.84	1.7	.37
8 & 9 yrs.	10	1.97	.47	4.0	2.61	.62	3.6	2.46*	1.97	.85	4.0	2.69	.65	3.6	2.02

*$p \leq .05$ = .44
**$p \leq .01$ = .56

the Poor Learners had gained only half a grade while the Good Learners were a full year better than the six and seven year olds. At the age of nine the Poor Learners were two grades retarded but the Good Learners were hehind only one.

The oral section of the Metropolitan Arithmetic Test could not be administered to deaf children. The raw score results for computation are presented in Table 38. At the six and seven year level no differences appeared in arithmetic skills. At the eight and nine year level the Good Learners scored three points higher, a difference which was significant at the five percent level. As in reading, six and seven years both groups were just beginning to develop mathematical skills; by nine years the good lipreaders had made good progress but as in other areas of educational achievement the poorer speechreaders were developing this ability more slowly.

The results for written language appear in Table 39. Among the six and seven year olds only one significant difference occurred and this was on Syntax. Generally the younger Poor Learners produced only lists of words while most of the Good Learners were able to formulate and write a story. The Poor Learners fell at the lowest percentiles of the test norms on all areas of written language and even were below the level for average deaf children. The Good Learners compared favorably with the deaf norms but were retarded when norms for the hearing were employed.

There were no differences on the productivity scores for the older children. These scores for the Poor Learners were like those of seven year old hearing children, while the Good Learners were at the 30th percentile for nine year olds. The Good Learners were significantly higher on words per sentence and syntax. The older Poor Learners scored more like seven year old deaf children while the Good Learners performed more like thirteen year olds. The Abstract-Concrete scores were not significantly different but the trend favored the better speechreaders.

These results are similar to observations made in the past, that those with good or superior speechreading ability demonstrate similar abilities in reading and writing. Apparently, a mutual relationship exists among what are essentially verbal symbolic skills. Also these results demonstrate a superiority of good speechreaders, a finding that has appeared in all other aspects of this investigation.

MOTOR ABILITY

The results for the measures of motor ability are presented in Tables 40, 41, and 42. The scores for general locomotor coordination, as represented by the Heath Railwalking Test, revealed no significant differences between the Good and Poor Learners at any age level. At four and five years the scores are below the recorded norms as would be expected, the test being designed for those six years or older. At six years the Poor Learners scored lower but they and the Good Learners were well within the norms for their age. The older age groups fell at the expected level. In addition, no differences between groups were noted on the Dynamometer ratings, again at each age level the subjects attained scores within the expected range.

TABLE 38

METROPOLITAN ARITHMETIC SCORES BY GROUP

	Poor Learners			Good Learners			"t"
	N	Mean	S.D.	N	Mean	S.D.	
6 & 7 years	10	10.8	6.08	10	16.8	9.01	1.66
8 & 9 years	10	20.3	3.95	10	23.6	.66	2.47*

*p ≤ .05 = 2.10

TABLE 39

PICTURE STORY LANGUAGE TEST SCORES BY GROUP

	6 & 7 Years							8 & 9 Years						
	Poor Learners			Good Learners				Poor Learners			Good Learners			
	N	Mean	S.D.	N	Mean	S.D.	"t"	N	Mean	S.D.	N	Mean	S.D.	"t"
Total Words	10	9.3	13.69	10	13.8	12.83	.72	10	27.1	22.90	10	65.0	54.62	1.92
Total Sentences	10	1.8	3.09	10	2.6	2.72	.58	10	4.3	4.63	10	10.2	9.08	1.74
Words Per Sentence	10	1.5	1.63	10	3.4	3.14	1.61	10	2.8	2.17	10	5.6	1.77	3.05**
Syntax	10	19.5	15.67	10	41.9	27.64	2.11*	10	40.2	29.45	10	74.3	22.04	2.78*
Abstract/Concrete	10	1.8	3.09	10	4.7	3.79	1.77	10	5.1	5.03	10	9.9	5.01	2.03

*p $\leq$ .05 = 2.10
**p $\leq$ .01 = 2.88

TABLE 40

HEATH RAILWALKING SCORES BY GROUP

	Poor Learners			Good Learners			
	N	Mean	S.D.	N	Mean	S.D.	"t"
4 & 5 years	10	9.4	12.00	10	12.1	14.65	.42
6 & 7 years	10	26.8	16.16	10	46.4	24.35	2.01
8 & 9 years	10	61.0	38.66	10	63.5	26.04	.16

$p \leq .05 = 2.10$

TABLE 41

DYNAMOMETER RAW SCORES FOR RIGHT HAND BY GROUP

	Poor Learners							Good Learners						
		Males			Females				Males			Females		
	N	Mean	S.D.	N	Mean	S.D.	"t"	N	Mean	S.D.	N	Mean	S.D.	"t"
4 & 5 year	5	4.24	2.50	5	3.80	1.93	.28	5	4.42	3.02	5	4.16	.93	.16
6 & 7 year	5	9.56	2.13	5	9.50	2.98	.03	5	10.44	2.43	5	9.04	3.00	.72
8 & 9 year	5	16.60	2.19	5	11.38	2.19	3.36**	5	12.24	1.86	5	11.82	4.38	.18

$p \leq .05 = 2.31$
$^{**}p \leq .01 = 3.36$

TABLE 42

DYNAMOMETER RAW SCORES FOR LEFT HAND BY GROUP

	Poor Learners							Good Learners						
		Males			Females				Males			Females		
	N.	Mean	S.D.	N	Mean	S.D.	"t"	N	Mean	S.D.	N	Mean	S.D.	"t"
4 & 5 year	5	4.40	1.71	5	3.26	1.74	.94	5	3.02	2.09	5	3.30	.89	.25
6 & 7 year	5	9.66	1.54	5	8.38	3.10	.74	5	10.58	2.62	5	7.68	2.67	1.55
8 & 9 year	5	12.30	6.78	5	11.24	3.14	.28	5	11.74	2.40	5	11.62	3.46	.06

$p \leq .05 = 2.31$

In addition to measures of gross locomotion and strength of grip, evidence of laterality was obtained through observation of the subjects' performance on tests of kicking, throwing, and writing. Myklebust (1966) and Boyd (1965) have reported higher incidences of left handedness and mixed laterality among the deaf suggesting immature and disturbed development of the central nervous system. Such disturbances would give implications for the development of verbal language functioning, including speechreading. The results of these tests are presented in Table 43. The data revealed no difference between the Poor Learners and Good Learners ($X^2 = 1.83$). Of the 29 subjects classified as Poor Learners, 19 or 65.6 percent were completely right sided while one or 3.5 percent was left; nine or 31.1 percent were mixed; on one of the three tests handedness was different from the other two. For the Good Learners, 22 or 75.9 percent were found to be right handed; 6.9 percent were left and five or 7.3 percent were mixed. Of particular interest were those classified as mixed; for the Poor Lipreaders eight of these were predominantly rights and one was left; for the Good Lipreaders it was four right and one left. When the mixed group were assigned to that category in which the majority of scores fell, the final total was 27 or 93.2 percent right for the Poor Learners and two or 6.8 percent left. This tally for the Good Learners was 26 or 89.8 percent right and three or 10.2 percent left. The walking age may also give a clue to central nervous system maturity--the data concerning this landmark was taken from the case history data. The mean walking age for the Poor Speechreaders was 15.4 months and for the Good Speechreaders, 13.1 months. For the total group the walking age was 14.2. The walking age for both groups is in agreement with previous findings for deaf children (Myklebust, 1954). The two months difference in favor of the Good Learners was significant at the five percent level ("t" = 2.66).

Tests of motor behavior did not reveal significant differences. However, the earlier walking age for the Good Learners foreshadowed the general superiority that has been observed for the Good Lipreaders.

TABLE 43

SUMMARY OF LATERALITY FINDINGS OF SUBJECTS BY GROUP

	Kicking				Throwing				Writing				Laterality					
	Right		Left		Right		Left		Right		Left		Right		Left		Mixed	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Poor Learners	25	86.3	2	6.9	27	93.1	2	6.9	26	89.6	3	10.4	19	65.6	1	3.5	9	31.1
Good Learners	26	89.6	3	10.4	27	93.1	2	6.9	26	89.6	2	9.6	22	75.9	2	6.9	5	17.3

OPHTHALMOLOGICAL FINDINGS

Studies of visual functioning in deaf children consistently have shown an incidence of visual impairment which is higher than that reported for the normally hearing. Crane (1954) in a study of first and fifth grade hearing children found that 26.9 percent were in need of treatment. Included in his group were children for whom there was a question as to the actual need for referral but in the opinion of the examiner conditions existed which required professional observation.

Braly (1937) in one of the first studies of visual acuity in the deaf reported an incidence of 38 percent among the total population of a residential school, with an age range of five to 21 years. Stockwell (1953) studying 960 children also attending a residential school found that 45.5 percent had deficient vision to the extent of requiring refraction, compared to 15 percent for normal children. Employing the Keystone Telebinocular, Myklebust (1964) reported an incidence of visual disorder of 51 percent. The most recent study was undertaken by Suchman (1967); her group consisted of 103 deaf children ranging in age from four to twelve years of whom 58 percent had some visual abnormality, subnormal acuity or a visual anomaly.

RESULTS

The present study offered an opportunity to explore the relationship between vision and auition in a hearing impaired population. In addition to the 60 subjects who comprised the study proper, an additional 21 also were given an ophthalmological examination (in the study group itself one subject could not complete the examination so results are reported for 80 children). The additional sample included those who for various reasons did not fit the study criteria or for whom information concerning general functioning was sought by one of the schools cooperating in the project. The eye findings for these 80 children are presented in Table 44.

Of the 80 children examined, 25 or 31.1 percent were diagnosed as having pathological conditions which warranted treatment; an additional 18 or 22.5 percent were judged to have visual functioning in the normal range in whom pathological conditions were present but which though not interferring with present functioning potentially could present problems. For example, among the four and five year olds only two or 10.5 percent were diagnosed as abnormal but 42.1 percent had some visual abnormality. In most instances the pathological condition noted was hyperopia.

When those with normal vision but with pathological conditions were combined with those with positive diagnoses more than half the children examined (53.6 percent) were classified as having some visual abnormality. This figure is consistent with previous studies. Although differences

TABLE 44

OPHTHALMOLOGICAL RESULTS FOR THE TOTAL POPULATION

	Normal		Pathological		Abnormal		X^2
	N	%	N	%	N	%	
4 & 5 Year Olds	9	47.3	8	42.1	2	10.5	7.4
6 & 7 Year Olds	11	50.0	3	13.7	8	36.3	
8 & 9 Year Olds	17	43.5	7	17.9	15	38.4	
Total Population	37	46.3	18	22.5	25	31.3	

Level of significance: $p \leq .05 = 9.49$

appeared among the various age levels these were not statistically significant ($X^2 = 7.4$; needed for significance at the .05 level = 9.49). Because the deaf child is markedly dependent on vision for maintenance of homeostasis, these results point up a need for regular ophthalmological examinations.

As previous studies were concerned with children attending residential schools for the deaf, there was the possibility that the high incidence of abnormality resulted from the more involved child being sent to these programs after having failed in day classes. The present study offered an opportunity to explore this possibility. In Table 45 are the data concerning incidence when the subjects were categorized according to school placement. Of the 29 children from the residential schools, 18 or 61.7 percent had some visual abnormality compared to 49.1 percent of the day pupils. Although this represented a trend in favor of a higher incidence among residential pupils the difference was not statistically significant ($X^2 = 2.68$; needed for significance at the .05 level, 5.99).

To study further the relation between hearing loss and visual abnormality the etiology of the hearing loss was examined; case history information was available from only the 60 subjects employed in the total study. These data are presented in Table 46.

Certain etiologies, as would be expected, were directly related to visual impairment; for example, of the six children with the etiology of maternal rubella, four were diagnosed as having abnormal vision while the other two had some visual anomaly. Three other subjects listed as unknown were found to have hyper-pigmentation of the macula suggesting maternal rubella as the cause of the hearing loss. Aside from the known rubella children, 21 subjects were found to have some visual difficulty; of these, nine or 42.8 percent, were classified as familial. These findings confirm Myklebust's suggestion that regardless of etiology there is a significant relation between deafness and visual abnormalities.

Table 47 presents a summary of the types of impairment that were found. The highest incidence was for hyperopia, reported for 22 or 27.5 percent. The next highest were myopia and astigmatism reported for 12.5 percent of the subjects. Comparable findings reported by Crane for the normally hearing were: hyperopia, 12.3 percent; myopia and astigmatism, 8.2 percent.

Hyper-pigmentation of the macula was observed in nine of the subjects while eight or 10 percent had difficulty with fusion, stereopsis, or convergence. In normal children (Crane, 1954) less than one percent (0.7) had difficulty in convergence. Of the eight children found to have fusion problems, four were considered good lipreaders.

SUMMARY

Data concerning the incidence of visual problems among the 60 subjects in the study proper is presented in Table 48. Twenty-seven or 37.3 percent had some visual abnormality. These deficiencies were distributed equally among the poor and good speechreaders ($X^2 = 1.83$). Ability to observe the lips and the face is an obvious requirement for a child to develop speechreading. Apparently, the visual deficiencies found had no long-term effect on this ability.

TABLE 45

OPHTHALMOLOGICAL RESULTS BY TYPE OF SCHOOL PLACEMENT

	Normal		Pathological		Abnormal		Total	X^2
	N	%	N	%	N	%	N	
Day School Population	26	50.9	12	23.5	13	25.6	51	
Residential School Population	11	37.9	6	20.4	12	41.3	29	2.68
Total Population	37	46.3	18	22.5	25	31.3	80	

Levels of significance: $P \leq .05 = 5.99$
$P \leq .01 = 9.21$

TABLE 46

OPHTHALMOLOGICAL FINDINGS BY ETIOLOGY

	Normal		Pathological		Abnormal	
	N	%	N	%	N	%
Undetermined	7	11.9	1	1.7	3	5.1
Familial	15	25.5	5	8.5	4	6.8
Rubella	-	--	2	3.4	4	6.8
Other Maternal Illness & Preg. Complications	5	8.5	1	1.7	3	5.1
Rh Incompatibility	1	1.7	-	--	-	--
Prematurity	-	--	1	1.7	-	--
Birth Injury	-	--	1	1.7	-	--
Menningitis	4	6.8	-	--	-	--
Other Childhood Diseases	-	--	1	1.7	1	1.7
	(N = 32)		(N = 12)		(N = 15)	

TABLE 47

OPHTHALMOLOGICAL DEFECTS BY TYPE OF ABNORMALITY (N=80)

	N	Percent
Hyperopia		
Right Eye	22	27.5
Left Eye	21	26.3
Myopia		
Right Eye	10	12.5
Left Eye	5	6.3
Astigmatism		
Right Eye	10	12.5
Left Eye	10	12.5
Fusion/Stereopsis	8	10.0
Ocular Fundi (Hyperpigmentation of Macula)	9	11.3
Color Vision	3	3.8
Convergence	3	3.8

TABLE 48

SUMMARY OF OPHTHALMOLOGICAL FINDINGS FOR THE EXPERIMENTAL GROUPS

	Poor Learners		Good Learners		Total	
	N	%	N	%	N	%
Normal Functioning	16	60.0	16	65.5	32	62.7
Pathological Conditions	5	13.3	7	13.7	12	13.5
Abnormal Functioning	9	26.7	6	20.8	15	23.8

THE NEUROLOGICAL STUDY

Only a few investigations of central nervous system functions in deaf children have been accomplished. Research on the psychology of learning also is limited on this type of handicapped child. Moreover, psychologists, as well as educators, essentially have been oblivious to the possibility that an association exists between deafness and modification of brain processes. On the presumption that it is the brain that learns and that brain functions might be altered in the presence of profound deafness in early life, we included both electroencephalographic and neurological studies in this investigation of learning failure. These two areas of professional endeavor provide basic techniques for investigation of the central nervous system electrophysiologically and neurophysiologically. We postulated that an in-depth study of learning and learning failure in deaf children should include evidence obtainable only through the collaboration of research workers representing these disciplines.

The theoretical construct encompassed the presumption that poor learning in deaf children to a degree might be explained by the presence of a dual handicap, deafness and brain dysfunction. Various studies have disclosed that diseases such as rubella and meningitis frequently cause deafness. Also, such diseases sometimes result in damage to the brain. From such evidence, especially in the past two decades, educators have reasoned that an undue number of children not only are deaf but also have impositions on learning because of dysfunctions in the brain. It is of importance that such presumptions be investigated through research. The practical implications are great for successful education of many deaf children because various considerations are involved. The educator must know whether the problem is one of the psychology by which the child learns when auditory experience is lacking, or whether he must be concerned with altered learning processes as a result of deafness and brain dysfunctions. The data presented below, and those gained from the other portions of this investigation, are enlightening in this regard. It appears that altered brain processes do characterize deaf children but not in the typical manner of the brain damaged. Rather the variations associated with the modification which derives from lack of auditory experience. This was shown most clearly by the electroencephalographic evidence, but in addition neurological disturbances were more common in the poor learners, as compared with the good learners.

RESULTS

A neurological examination was completed for all of the 60 deaf subjects, comprising the research sample. These findings were classified by the neurologist as normal, marginal, or abnormal, and tabulated for statistical analysis using computerized procedures. The incidence of neurological involvements as determined by the general classification is shown by the data in Table 49. Of the 60 subjects, 12 or 20 percent were classified as abnormal and 17 or 28.3 percent were labeled marginal. When these groups were combined, 29 or 48.3 percent were found to be other than normal neurologically. Though this figure is high it does not exceed the incidence found for normally hearing children as determined recently by another of our research studies (Myklebust, 1969); suspect or positive neurological signs were reported for 40 percent of a sample of normal children.

It is apparent also, from Table 49, that Good and Poor Learners are equivalent so far as general neurological classification was based on the clinical neurologist's opinion as to the implication of his findings. He judged certain signs, often referred to as hard signs, as being abnormal, while others were judged as being of marginal consequence--marginal indications often are referred to as soft signs. The data in Table 49 reveal that such experienced, professional judgments do not differentiate good deaf learners from those who are poor learners.

The abnormal and marginal findings were tabulated separately; see Table 50. As this tabulation shows, no group differences were manifested; Good and Poor Learners were equivalent. The highest incidence of abnormal signs occurred for deep reflexes, followed by superficial reflexes, cerebellar and cranial nerves. Disturbances of deep reflexes also was the most common sign in the marginal classification; combined (abnormal and marginal) 31.7 percent of the deaf children demonstrated deviation of deep reflexes. Though these data did not differentiate between the learning groups, further research is needed to clarify the nature of neurological dysfunctions in hearing impaired children.

The neurologist made 137 different observations of each child's central nervous system functioning (see Appendix). No positive findings were recorded for any subject on 119 of these observations. The Z test of significance was used to ascertain whether the proportion of normalcy for the other 18 determinations differentiated between Good and Poor Learners; see Table 51. Only three indicators (tandem walking, hopping-right and left) reached the .01 level of statistical significance; none fell at the .05 level or above. In all instances these trends favored the Good Learners. It is of interest that these indicators concern locomotor coordination and balance. Accordingly, it might be that the Poor Learners were slightly inferior to the Good Learners in certain motor functions. Otherwise, these data are highly negative insofar as relationships between learning and neurological functions are concerned.

Additional consideration of the neurologist's findings involved tabulating the number of signs (abnormal and marginal) per learning group; these data comprise only the incidence of each sign. The results from this tabulation are shown in Table 52. It is of considerable consequence that more signs categorized as abnormal appeared in the Poor Learners and more of the marginal signs in the Good Learners (.01 level of significance). When the neurological examiner elicited a positive sign in a Poor Learner he was more confident that it was a true abnormality; similarly he was less confident of the signs in Good Learners, hence, was more disposed to record them as marginal.

TABLE 49

GENERAL NEUROLOGICAL CLASSIFICATION BY GROUP

	Poor Learners (N=30)		Good Learners (N=30)		Total (N=60)		X^2
	N	%	N	%	N	%	
Normal	14	46.7	17	56.7	31	51.7	
Abnormal	6	20.0	6	20.0	12	20.0	.82
Marginal	10	16.7	7	23.3	17	28.3	

Significance level: $p \leq .05 = 5.99$

TABLE 50

SPECIFIC ABNORMAL AND MARGINAL NEUROLOGICAL FINDINGS BY GROUP

	Poor Learners (N=30)		Good Learners (N=30)		Total (N=60)	
	N	%	N	%	N	%
Abnormal Signs						
Deep Reflexes	4	13.3	2	6.7	6	10.0
Superficial Reflexes	1	3.3	3	10.0	4	6.7
Cranial Nerves	1	3.3	1	3.3	1	3.3
Cerebellar Nerves	3	10.0	1	3.3	4	6.7
Marginal Signs						
Deep Reflexes	6	20.0	7	23.3	13	21.7
Superficial Reflexes	-	--	-	--	-	--
Cranial Nerves	0	--	1	3.3	1	1.7
Visceral Nerves	1	3.3	0	--	1	1.7
Cerebellar Nerves	2	6.7	1	3.3	3	5.0

TABLE 51

THE FREQUENCY OF NEUROLOGICAL SIGNS BY GROUP

	Proportion of Normalcy		
	Poor Learners	Good Learners	Z
Knee Jerk-Right	86.2	92.0	- .6568
Knee Jerk-Left	89.7	88.0	.1925
Triceps Jerk-Right	96.4	96.0	.0731
Triceps Jerk-Left	96.4	96.0	.0731
Biceps Jerk-Right	96.4	96.0	.0731
Biceps Jerk-Left	96.4	96.0	.0731
Plantar B-Right	90.5	78.9	1.0256
Plantar B-Left	85.7	78.9	.5647
Tandem Walking	91.3	100.0	1.4309+
Standing: Right Foot	87.0	95.6	1.0436
Standing: Left Foot	87.0	95.4	.9976
Hopping: Right Foot	88.2	100.0	1.4640+
Hopping: Left Foot	88.2	100.0	1.5108+
Tongue Protrusion	100.0	94.7	1.1856
Romberg	92.6	96.9	.7275
Ankle Jerk: Right	100.0	96.0	1.1111
Ankle Jerk: Left	95.8	100.0	.9395
Fundi	95.8	100.0	.9395

Significance level: $^{+}p \leq .10 = 1.23$

TABLE 52

INCIDENCE OF NEUROLOGICAL SIGNS BY GROUP

	Number of Signs		
	Poor Learners	Good Learners	Z
Abnormal	27	11	5.74**
Marginal	2	7	4.01**

Significance level:**$p \leq .01 = 2.06$

TABLE 53

NEUROLOGICAL FINDINGS BY ETIOLOGICAL GROUP

	Normal (N=31)		Marginal (N=17)		Abnormal (N=12)		
Etiology	N	%	N	%	N	%	X^2
Endogenous	12	38.7	8	47.0	5	41.7	
Exogenous	11	35.5	8	47.0	6	50.0	3.69
Undetermined	8	25.8	1	6.0	1	8.3	

Significance level: $p \leq .05 = 9.488$

A somewhat more direct interpretation of these data might be made. If a child was classified as a Poor Learner, in comparison with a Good Learner, he manifested more neurological signs of disorders in the central nervous system. To a degree these results support the presumption that deaf children who are unsuccessful in learning to speechread tend to have a handicap in addition to deafness; they also have a learning disability which appears to be psychoneurological in nature. On the other hand, in view of the negative findings reported above, a conclusion to this effect can be made only tentatively and with caution. Though, in a sense, these data clearly demonstrate more central nervous system disturbances in the Poor Learners, further research evidence must be obtained before more definitive interpretations can be made.

To further investigate the possibility that diseases (rubella, meningitis, etc.) as a major factor were associated with poor learning an analysis was made on the basis of etiology; see Table 53. These results were negative. Normal, abnormal and marginal signs appeared with equal frequency in the etiological groups. Whether the deafness appeared to be due to hereditary factors or to known disease processes was inconsequential so far as the neurological findings were concerned. In view of the results presented in Table 52, it appears that irrespective of the etiology of the deafness, more neurological disturbances are found in those who present deficiencies in learning.

SUMMARY

In this facet of the research project we investigated the possibility that poor learning in deaf children was related to dysfunctions of the central nervous system as determined by a specialist in neurology. Though some of the results were negative, there was a firm indication that the incidence of abnormalities was higher in the Poor Learning Group. More research evidence is needed, but if this finding were corroborated it would be necessary to reconsider the total needs of these children. Educationally they might be viewed as multiple handicapped children, in need of a program which combines the methodologies evolved for the deaf with those found to be beneficial for children with psychoneurological learning disabilities. Another implication, enhanced by the results obtained from the ophthalmological and electroencephalographic studies, is that there are unmet medical needs. Drugs of the type used for children with brain dysfunctions might be helpful and in some instances stabilize learning processes. As a minimum, all deaf children who present problems in learning, and even those who do not, should have intensive diagnostic study. In addition to detailed educational and psychological examinations, ophthalmological, neurological, and electroencephalographic studies seem imperative if the child's total needs are to be adequately considered.

The implication is that we should overcome the tendency to "fly-blind" in the field of deaf education and view these children in other terms than whether or not they should be taught orally or manually. This long-held argument at best is naive and superficial. To a substantial degree the results from this investigation indicate that deafness from early life alters the neurological system and the psychoneurological processes by which the child learns. Only when educational programming takes cognizance of this fact will real progress be made in meeting the needs of this type of handicapped child.

It should be mentioned also that similar psychoneurological dysfunctions might appear in the blind, and in the deaf-blind. Therefore, there is an urgent need for comparative studies of these groups of sensorially deprived children. Not only in the manner suggested by this study but "brain banks" should be established. Through such banks neuropathological and histological post-mortem studies could be achieved. It is noteworthy that Love (1911) in the early 1900's made the following comments on the post-mortem brain findings for Laura Bridgman:

> The examination of the brain showed that those portions which from youth up could not be brought into activity in the ordinary way through external impressions, viz., all the cerebral nerves, were small, the gustatory nerve, the auditory nerve, and a nerve that moves the eyeballs were stunted, and this was especially true of the tract of the optic nerves. The cerebral hemispheres appeared somewhat flattened behind, and the occipital lobe, in fact, smaller on the right than on the left, and right cuneus much less developed than the left. This difference in the region belonging to the visual centres is intelligible when we consider that Miss Bridgman from her second year was completely blind with the left eye, whereas with the right she retained some sensation of light until her eighth year, enough at any rate to allow the development of the centres of the left side to go on. (Myklebust, 1964, p. 358)

When the results from the neurological study are combined with those from the electroencephalographic, ophthalmological and psychoeducational it is apparent that new thinking and innovative planning are necessary in deaf education.

THE ELECTROENCEPHALOGRAPHIC STUDY

TECHNIQUE

The electroencephalographic examinations were made at Evanston Hospital under the direction of a trained technician experienced with children of this age. However, because she was not experienced with deaf children an additional research staff member was present. This staff member, an experienced teacher of the deaf, already had developed a relationship with the child through administration of psychological and educational tests, all of which had been completed prior to the EEG studies. The presence of this staff member aided in communicating instructions to the child and also helped to allay anxieties concerning the examination. The procedures were those used regularly in electroencephalography. Employing the 10 - 20 International System of Electrode Placement, 22 leads were attached symmetrically over the scalp at equal distances from each other. The electrodes were secured by dried collodion, the conducting paste being applied on the area of the scalp to be monitored.

Both referential (2) and bipolar (6) montages were used during the recording from an 8-channel Grass, Type 6 EEG unit. The effect of eye-opening and eye-closure was tested as was the effect of activation from five minutes of hyperventilation. In addition, response to photic stimulation at different frequencies was appraised. Sleep records also were obtained.

RESULTS

The results from the EEG study were analyzed in two principal ways. First, we compared the findings for Good and Poor Learners; both samples were comprised of deaf children (see Tables 54 through 68). Second, the deaf sample was compared with a control group of normally hearing children (see Tables 69 through 85). In all instances the electroencephalographer read the records without knowledge of the child's history; he was unaware as to whether the child was a Good or Poor Learner.

Good vs. Poor Learners

The EEG scientist read the records and classified them as either normal or abnormal. These data are shown in Table 54. There was no significant difference between good and poor learners in the incidence of abnormality in the EEG. Of the 60 deaf subjects, 23 or 38 percent showed some disturbance in electrocortical output. Analyses were made in comparing the groups by type of abnormality (Table 55), focus of the abnormality (Table 56), and by area of response (Table 57). Again the data disclosed no differences by group.

TABLE 54

ELECTROENCEPHALOGRAPHIC FINDINGS FOR DEAF SUBJECTS BY GROUP

	Poor Learners (N=30)		Good Learners (N=30)		Total (N=60)		
	N	%	N	%	N	%	X^2
Normal	20	66.7	17	56.7	37	61.7	.63
Abnormal	10	33.3	13	43.3	23	38.3	

Significance level: $p \leq .10 = 2.71$

TABLE 55

TYPES OF ABNORMALITY
FOR DEAF SUBJECTS BY GROUP

	Poor Learners (N=10)[a]	Good Learners (N=13)[a]	Total (N=23)[a]
Slow Wave Forms			
Slow Waves	1	3	4
Diffuse Slow Waves	0	1	1
Slow and Diffuse	0	1	1
Slow and Spindle	1	0	1
Slow, Spindle, and Spike	0	1	1
Sharp Wave Forms			
Sharp Waves	1	1	2
Spiking	3	5	8
Sharp and Positive Spikes	1	0	1
Sharp and Mild Slowing	1	0	1
Spike and Slow	0	1	1
Spindle Activity	2	0	2

[a] A subject may show more than one type of abnormality.

TABLE 56

FOCUS OF ABNORMALITY
FOR DEAF SUBJECTS BY GROUP

	Poor Learners (N=10)[a]	Good Learners (N=13)[a]	Z
Occipital	3	4	-.19
Frontal	1	2	.41
Central	2	3	.26
Thalamic-Hypothalamic	4	6	.26
Temporal	4	1	1.34+

Significance levels: + $p \leq .10 = 1.23$; + $p \leq .05 = 1.56$

[a] A subject may show more than one type of response.

TABLE 57

AREA OF RESPONSE TO HYPERVENTILATION
FOR DEAF SUBJECTS BY GROUP

	Poor Learners (N=14)	Good Learners (N=11)	Z
Occipital	7	10	.50
Frontal and Central	8	2	.15
Parietal	1	2	.41

Significance level: $p \leq .10 = 1.23$

The background rhythm (alpha) typically is analyzed both in terms of organization (rhythmicity) and in terms of development (amplitude). The data on organization are presented in Table 58. As can be seen, none of the records were classified as being very well organized and none fell at the levels of poorly or very poorly; all were categorized as well, moderately well, or fairly well. The groups were equivalent with essentially the same incidence of each categorization. Similarly, no group differences appeared in the development of the EEG; see Table 59. Again, the records fell within the range of the three least variable categories: well, moderately well, and fairly well.

The frequency of the output also was studied; disturbances of frequency have well established clinical implications. The data on this facet are shown in Table 60. Again, statistically significant differences by group did not appear. There seems to be no relationship between learning and frequency of the electrocortical output.

Hemisphere differences are of considerable interest in all aspects of EEG study. We were especially curious with respect to this facet inasmuch as certain of our behavioral investigations had suggested that the degree of cerebral dominance, on the average, was reduced by early life deafness. It was postulated that hemisphere asymmetries might be associated with facility in learning. However, as shown by the results in Table 61, such group differences were not revealed. On the other hand, depressions on the right hemisphere are clinically noteworthy and two subjects in the poor learning group manifested such a disturbance.

Symmetry and laterality also were studied under photic stimulation; see Table 62 and Table 63. This comparison also failed to reveal group differences. The quality of responses to photic stimulation (Table 64) likewise showed no association with facility in learning; though, as discussed below, these responses were different in comparison with the hearing.

The EEG results obtained during sleep often are highly important in clinical diagnosis. So far as we have been able to ascertain there are no previous reports of EEG findings for deaf children while asleep. Hence, we were keenly interested inasmuch as we hypothesized that the brain of a deaf child would be "running unduly quiet" during sleep because both auditory and visual inputs are precluded; a situation comparable to the deaf-blind, and to that found in the sensory deprivation experiments (Zubek, 1969). Nevertheless, the data shown in Tables 65, 66, and 67 reveal no group differences for good and poor learners. Though we are confident of these findings, our experience was that it is difficult to obtain sleeping records for young deaf children.

The final comparison entailed the etiology of the deafness; see Table 68. So far as the present sample is concerned, the incidence of EEG disorders was not related to causation. Abnormalities occurred with equal frequency, whether the deafness was attributed to disease or to hereditary factors.

In summary, the findings from this portion of the EEG study showed no direct association with facility in learning. Deaf children classified

TABLE 58

ORGANIZATION OF BACKGROUND RHYTHM FOR DEAF SUBJECTS BY GROUP

	Poor Learners (N=30)		Good Learners (N=30)		Total (N=60)	
	N	%	N	%	N	%
Very Well	--	--	--	--	--	--
Well	8	26.7	7	23.3	15	25.0
Moderately Well	20	66.7	20	66.7	40	66.7
Fairly Well	2	6.7	3	10.0	5	8.3
Poorly	--	--	--	--	--	--
Very Poorly	--	--	--	--	--	--

TABLE 59

DEVELOPMENT OF BACKGROUND RHYTHM
FOR DEAF SUBJECTS BY GROUP

	Poor Learners (N=30)		Good Learners (N=30)		Total (N=60)		
	N	%	N	%	N	%	X^2
Very Well	--	--	--	--	--	--	
Well	20	66.7	25	83.3	45	75.0	
Moderately Well	8	26.7	4	13.3	12	20.0	2.8
Fairly Well	2	6.7	1	3.3	3	5.0	
Poorly	--	--	--	--	--	--	
Very Poorly	--	--	--	--	--	--	

Significance level: $p \leq .10 = 6.25$

TABLE 60

FREQUENCY OF BACKGROUND RHYTHM
FOR DEAF SUBJECTS BY GROUP

	Poor Learners (N=30)		Good Learners (N=30)		Total (N=60)		
c/sec.	N	%	N	%	N	%	X^2
7 - 7.9	2	6.7	1	3.3	3	5.0	
8 - 8.9	7	23.3	12	40.0	19	31.7	
9 - 9.9	15	50.0	15	50.0	30	50.0	4.45
10 - 10.9	4	13.3	2	6.7	6	10.0	
11 - 11.9	2	6.7	--	--	2	3.3	

Significance level: $p \leq .10 = 4.60$

TABLE 61

SYMMETRY OF BACKGROUND RHYTHM FOR DEAF SUBJECTS BY GROUP

	Poor Learners (N=30)		Good Learners (N=30)		Total (N=60)	
	N	%	N	%	N	%
Bilaterally Symmetrical and Synchronous	26	86.7	27	89.9	53	88.5
Slightly Depressed on Left	2	6.7	3	10.0	5	8.3
Slightly Depressed on Right	2	6.7	--	--	2	3.3

TABLE 62

SYMMETRY OF PHOTIC DRIVING FOR DEAF SUBJECTS BY GROUP

	Poor Learners (N=17)		Good Learners (N=20)		
	N	%	N	%	Z
Without Significant Asymmetry	5	29.4	12	60.0	.30
Significant Asymmetry	12	70.6	8	40.0	.06

Significance level: $p \lesssim .10 = 1.23$

TABLE 63

LATERALITY OF DEPRESSION DURING PHOTIC DRIVING FOR DEAF SUBJECTS BY GROUP

	Poor Learners (N=12)		Good Learners (N=8)		
	N	%	N	%	X^2
Left	8	66.7	6	75.0	1.59
Right	4	33.3	2	25.0	

Significance Level:$p \leq .10 = 2.71$

TABLE 64

QUALITY OF DRIVING DURING PHOTIC STIMULATION FOR DEAF SUBJECTS BY GROUP

	Poor Learners (N=17)		Good Learners (N=20)		
	N	%	N	%	X^2
Excellent	-	-	-	-	
Good	5	29.5	6	30.0	.002
Fair	-	-	-	-	
Poor	11	70.5	14	70.0	

Significance level:$p \leq .10 = 2.71$

TABLE 65

SLEEP RESULTS
FOR DEAF SUBJECTS BY GROUP

	Poor Learners (N=30)		Good Learners (N=30)		
	N	%	N	%	Z
Sleep Achieved	24	80.0	25	83.3	.003
No Sleep Record	6	20.0	5	16.7	.34

Significance Level: $p \leq .10 = 1.23$

TABLE 66

LEVEL OF SLEEP OBTAINED
FOR DEAF SUBJECTS BY GROUP

	Poor Learners (N=30)		Good Learners (N=30)		Total (N=60)	
	N	%	N	%	N	%
Did Not Sleep	4	13.3	3	10.0	7	11.7
Sleep Achieved	21	69.9	22	73.3	43	71.7
Light Sleep Achieved	3	10.0	3	10.0	6	10.0
Drowsiness	2	6.7	2	6.7	4	6.7

TABLE 67

SLEEP RESULTS BY TYPE OF RESPONSE FOR DEAF SUBJECTS BY GROUP

	Poor Learners (N=24)	Good Learners (N=25)	Z
Normal Symmetrical and Synchronous Patterns	15	18	.78
Bursts of 7&14/Sec. Positive Spikes	4	6	.26
High Amplitude Spindles	3	1	1.00
Sharp Waves	3	1	1.00

Significance level: p $\leq$ .10 = 1.23

TABLE 68

EEG FINDINGS BY ETIOLOGICAL GROUP FOR DEAF SUBJECTS

	Normal EEG (N=37)		Abnormal EEG (N=20)		X^2
	N	%	N	%	
Endogenous	15	25.0	10	16.7	
Exogenous	16	26.7	9	15.0	.10
Undetermined	6	10.0	4	6.7	

Significance level:p $\leq$ .10 = 4.60

as good or poor in ability to learn to read the lips were equivalent insofar as the EEG findings are concerned. It is important, however, to consider these results in connection with the findings reported below. Additional EEG analysis disclosed differences in comparison with the hearing. Moreover, the neurological study data also suggest that brain processing differences cannot be overlooked, even in relation to facility in learning.

Deaf vs. Hearing Children

Though electroencephalography as a field has grown rapidly, virtually no scientific study has been made of electrocortical processes in deaf children in comparison with the hearing. As originally proposed, such an investigation was not part of this research project. But through a set of fortunate circumstances an investigation of this type was included.

During the past four years we have conducted an extensive interdisciplinary research study involving hearing children with and without deficits in learning. There were over 200 normal children who were achieving educationally at a level commensurate with their mental and chronological ages on whom we had made complete electroencephalographic examinations. From this group we selected all subjects between the ages of six and ten (none below six years of age were available) and placed them in a pool. Forty subjects were chosen randomly out of this pool and matched in age and sex with the older children comprising our sample in the study of failure to learn to lipread. The EEG results for the two groups, hearing and deaf, then were compared; computerized statistical techniques were employed. These data are presented in Tables 69 through 85.

General Classification: The electroencephalographer classified the records on the basis of normal and abnormal. In Table 69 we see that no differences appeared when the deaf and hearing were compared on this general basis; the incidence of abnormality was equivalent for the two groups. If this finding were interpreted to mean that the electrocortical functions in deaf and hearing children are identical the implications would be highly misleading. To explore these functions in detail a much more intensive analysis was made. As shown below, when parameters other than general classification are used, critical differences were revealed.

Focus of Abnormality: For those who showed an abnormality (16 out of the 40 deaf children who fell above six years of age, and 12 out of the normal population of 40 hearing children) an analysis was made of the area of focus of the involvement. From these results, though the number of subjects was small, it appears that there is a tendency for the abnormality in deaf children to be localized in the occipital (Table 70), frontal, and central regions of the cortex (Tables 71 and 72). Other findings, as shown below, also implicate malfunctioning in the occipital region. However, the evidence at hand does not make it possible to explain this difference of focus in deaf children. Conceivably, when audition is lacking the greatest activity occurs in the occipital-frontal portion, not in the temporal region which comprises the principal auditory cortical area. In addition, it might be assumed that when auditory stimulation is lacking, and certain areas are not activated in the usual manner, the

TABLE 69

ELECTROENCEPHALOGRAPHIC FINDINGS FOR THE DEAF AND HEARING

	Deaf (N=40)		Hearing (N=40)		
	N	%	N	%	X^2
Normal	24	60.0	28	70.0	1.03
Abnormal	16	40.0	12	30.0	

Significance level: $p \leq .10 = 2.71$

TABLE 70

FOCUS OF ABNORMALITY FOR DEAF AND HEARING

	Deaf (N=16)[a]	Hearing (N=12)[a]	Z
Occipital	5	1	1.63*
Frontal	3	0	1.16
Central	4	1	1.34+
Temporal	2	5	.51
Thalamic-Hypothalamic	6	8	.19

Significance levels: +$p \leq .10$ = 1.23; *$p \leq .05$ = 1.56;
**$p \leq .01$ = 2.06

[a] A subject may show abnormality in more than one area of the brain.

TABLE 71

FOCUS OF ABNORMALITY FOR DEAF AND HEARING

	Deaf (N=16)[a]	Hearing (N=12)[a]	Z
Occipital, Frontal, and Central	12	2	1.89*
Temporal	2	5	-.51
Thalamic-Hypothalamic	6	8	.19

Significance levels: $*p \leq .05 = 1.56$; $**p \leq .01 = 2.06$

[a] A subject may show abnormality in more than one area of the brain.

TABLE 72

FOCUS OF ABNORMALITY FOR DEAF AND HEARING

	Deaf (N=16)[a]	Hearing (N=12)[a]	X^2
Cortical Areas			
Occipital, Frontal, Central, and Temporal	14	7	1.94
Subcortical Areas			
Thalamic-Hypothalamic	6	8	

Significance level: $p \leq .10 = 2.71$

[a] A subject may show abnormality in more than one area of the brain.

electrocortical functions as represented by other areas are processed and organized differently.

Organization of Background Rhythm: The background rhythm (alpha waves) as used by electroencephalographers, has been indicative of various types of disturbances of electrocortical processes. In this study we analyzed the background rhythm results in three ways: see Tables 73, 74, and 75. First we compared the findings for all six levels of organization (rhythmicity); Table 73. The records for the deaf subjects fell into only three categories (well, moderately well, fairly well), whereas those for the hearing ranged from well through very poorly. Statistically there was a trend (10 percent level of significance) for the background rhythm in the deaf to be unduly organized.

To pursue the possibility that the alpha wave activity varied for deaf and hearing children we combined the categories of well and moderately well and the categories of fairly well, poorly, and very poorly. The findings for this comparison are shown in Table 74. These data disclose a group difference at the .05 level of significance. Again the results indicate that in the deaf the background rhythm comparatively is unusually well organized and rhythmical.

Another analysis showed this difference even more conclusively; see Table 75. The groups were compared on the combined categories of well and moderately well. The level of difference now fell at .01. Taken as a whole these data firmly suggest that electrocortical functions are altered by profound early life deafness. When audition is lacking the alpha rhythm is unduly synchronized and organized.

Development of Background Rhythm: The alpha function was studied further using the criterion of development (amplitude); see Tables 76, 77, and 78. Again differences between the deaf and hearing appeared. The range of amplitude for the deaf fell only into three categories (well, moderately well, and fairly well), whereas for the deaf the range covered five levels. Moreover, for the deaf the amplitude of the background rhythm was unusually well developed in comparison with the hearing: .01 level of significance. From Tables 77 and 78 we find that this difference was consistent when the groups were compared in other ways.

The development and organization of the alpha rhythm has been viewed as expressing the extent to which the brain is reposed. Hence, these data suggest that the brain of deaf children is markedly and unduly reposed. Perhaps, we can infer that when auditory stimulation and experience is lacking the brain is remarkably quiet. It is reposed beyond the normal. Though additional evidence must be secured, there is the possibility that the more the brain shows this quietness, the greater the imposition on certain types of learning.

Frequency and Symmetry of Background Rhythm: The alpha function was analyzed also in terms of frequency and symmetry; see Tables 79 and 80. Neither of these parameters disclosed differences. The variations in rhythm and amplitude cannot be attributed to disturbances of frequency or symmetry.

TABLE 73

ORGANIZATION OF BACKGROUND RHYTHM FOR DEAF AND HEARING

	Deaf (N=40)		Hearing (N=40)		
	N	%	N	%	X^2
Very Well	-	-	-	-	
Well	13	32.5	12	30.0	
Moderately Well	23	57.5	16	40.0	
Fairly Well	4	10.0	8	20.0	6.93+
Poorly	-	-	3	7.5	
Very Poorly	-	-	1	2.5	

Significance level: $+p \leq .10 = 6.25$; $p \leq .05 = 7.82$

TABLE 74

ORGANIZATION OF BACKGROUND RHYTHM FOR DEAF AND HEARING

	Deaf (N=40)		Hearing (N=40)		
	N	%	N	%	X^2
Well & Moderately Well	36	90.0	28	70.0	5.00*
Fairly Well, Poorly, and Very Poorly	4	10.0	12	30.0	

Significance level: $p \leq .01 = 6.64$; $*p \leq .05 = 3.84$

TABLE 75

ORGANIZATION OF BACKGROUND RHYTHM FOR DEAF AND HEARING

	Deaf (N=40)		Hearing (N=40)		
	N	%	N	%	Z
Well & Moderately	36	90.0	28	70.0	2.24**

Significance level: **p≤.01 = 2.06

TABLE 76

DEVELOPMENT OF BACKGROUND RHYTHM FOR DEAF AND HEARING

	Deaf (N=40)		Hearing (N=40)		
	N	%	N	%	X^2
Very Well	--	--	2	5.0	
Well	30	75.0	17	42.5	
Moderately Well	7	17.5	12	30.0	18.4**
Fairly Well	3	7.5	7	17.5	
Poorly	--	--	2	5.0	

Significance level: **p≤.01 = 13.28

TABLE 77

DEVELOPMENT OF BACKGROUND RHYTHM FOR DEAF AND HEARING

	Deaf (N=40)		Hearing (N=40)		
	N	%	N	%	X^2
Well	30	75.0	17	44.7	7.45**
Moderately Well, Fairly Well, and Poorly	10	25.0	21	55.3	

Significance level: $**p \leq .01 = 6.64$

TABLE 78

DEVELOPMENT OF BACKGROUND RHYTHM FOR DEAF AND HEARING

	Deaf (N=40)		Hearing (N=40)		
	N	%	N	%	Z
Well	30	75.0	17	42.5	2.95**

Significance level: $**p \leq .01 = 2.06$

TABLE 79

FREQUENCY OF BACKGROUND RHYTHM FOR DEAF AND HEARING

	Deaf (N=40)		Hearing (N=40)		
c/sec.	N	% S	N	%	X^2
7 - 7.9	-	-	-	-	2.23
8 - 8.9	9	22.5	7	17.5	
9 - 9.9	23	57.5	19	47.5	
10 - 10.9	6	15.0	12	30.0	
11 - 11.9	2	5.0	2	5.0	

Significance levels: $p \leq .10 = 4.60$

TABLE 80

SYMMETRY OF BACKGROUND RHYTHM FOR DEAF AND HEARING

	Deaf (N=40)		Hearing (N=40)		
	N	%	N	%	X^2
Bilaterally Symmetrical & Synchronous	36	90.0	31	77.5	4.40
Slightly Depressed on Left	4	10.0	5	12.5	
Slightly Depressed on Right	0	-	2	5.0	
Moderately Depressed on Left	0	-	2	5.0	

Significance level: $p \leq .10 = 6.25$

Response to Photic Driving: Photic stimulation has been used extensively in EEG and found to be of importance in disclosing various types of abnormalities. The responses to photic stimulation for the deaf and hearing subjects are presented in Tables 81, 82 . These data are unusually revealing. From Table 81 we note that driving occurred in fewer deaf subjects in comparison with the hearing; .05 level of significance. In the presence of deafness the driving response to photic stimulation appeared less frequently.

Moreover, the results shown in Table 82 disclose that when driving occurred the quality was inferior; level of significance was below .01 but beyond .05. These findings from the study of photic stimulation indicate that the visual area of the brain (occipital lobe) in deaf children has different response characteristics in comparison with children who have normal hearing. Fewer deaf children showed the driving effect and in those in whom a response occurred the quality of the output was inferior. The nature of this difference electrocortically is not clear. However, the visual perceptual behavior of deaf children also varies from the normal (Myklebust and Brutten, 1953; Myklebust, 1964). In addition, as shown by our investigation of ophthalmological factors (see page 64), visual functions in deaf children also are inferior. More study is necessary to clarify whether these various types of findings are related. At this time we can only infer that lack of audition alters visual processes in the brain. It may be that full maturity of function (i.e., in visual behavior) assumes interaction and integration of all other sensory information. The implications for study of learning in the deaf, the blind, and the deaf-blind are of considerable consequence.

Sleep Results: We have mentioned that we were keenly interested in the EEG findings while asleep. These data for the deaf and hearing are presented in Tables 83 and 84. No group differences were found in either the level of sleep achieved or in the type of response. It seems that the differences between the deaf and the hearing are not directly related to sleep. In other words, whether the brain is further reposed, as in sleep, is not the critical factor. Rather, it is the effect of lack of auditory stimulation per se; it is the sensory deprivation of deafness that is consequential, not the limitation of input and activation that accompanies the sleeping state.

Response to Hyperventilation: In addition to photic stimulation, the brain can be activated by hyperventilation (rapid deep breathing) while the EEG is being made. In comparing the deaf and hearing the area of response to hyperventilation was recorded; see Table 85. It is noteworthy that no group differences were found. Unlike the activation produced through a sensory modality (photic stimulation), activation through hyperventilation was not of consequence. Whatever the eventual basis of the differences between the deaf and hearing might be, they seem not to be related to activation of the type produced by hyperventilation.

SUMMARY

The electroencephalographic study was revealing in certain basic ways. First, though relationships between EEG results and facility in learning have been found in the past, no such findings derived from this

TABLE 81

RESPONSE TO PHOTIC DRIVING FOR DEAF AND HEARING

	Deaf (N=39)		Hearing (N=40)		
	N	%	N	%	X^2
Driving Occurred	27	69.2	35	87.5	3.90*
No Driving Occurred	12	30.8	5	12.5	

Significance level: *$p \leq .05 = 3.84$

TABLE 82

QUALITY OF DRIVING DURING PHOTIC STIMULATION FOR DEAF AND HEARING

	Deaf (N=27)		Hearing (N=35)		
	N	%	N	%	X^2
Excellent	-	-	7	20.0	
Good	9	33.3	15	42.9	5.31*
Poor	18	66.7	13	37.1	

Significance level: *$p \leq .05 = 3.84$

TABLE 83

LEVEL OF SLEEP FOR DEAF AND HEARING

	Deaf (N=40)		Hearing (N=40)	
	N	%	N	%
Did Not Sleep	2	5.0	1	5.0
Sleep Achieved	21	80.0	26	90.0
Light Sleep Achieved	4	10.0	1	2.5
Drowsiness	2	5.0	1	2.5

TABLE 84

SLEEP RESULTS BY TYPE OF RESPONSE FOR DEAF AND HEARING

	Deaf (N=36)[a]	Hearing (N=36)[a]
Normal Symmetrical and Synchronous	26	28
Bursts of 7&14/Sec. Positive Spikes	6	8
High Amplitude Spindles	2	0
Sharp Waves	3	0

[a] A subject may show more than one type of response.

TABLE 85

AREA OF ACTIVATION BY HYPERVENTILATION FOR DEAF AND HEARING

	Deaf (N=29)[a]	Hearing (N=21)[a]	Z
Occipital	16	11	.29
Frontal & Central	10	12	.12
Parietal	3	2	.32

Significance level: $p \leq .10 = 1.23$

[a] A subject may show more than one area of activation.

investigation. The Good and Poor Learners were equivalent with comparable electrocortical functions.

When deaf and hearing children were compared, however, highly significant differences were found. The alpha rhythm in deaf children varied from the normal in both organization and development. In the presence of deafness alpha activity is unduly rhythmical, synchronized and high in amplitude.

Another significant outcome pertains to responses to photic stimulation. Moreover, in those showing a driving effect the quality of the output was inferior.

The implications for learning and adjustment in the deaf are not clear at this time. Nevertheless, educators and psychologists should be aware that deafness appears to alter brain processes. This alteration may account for the differences in memory and other behavioral attributes frequently mentioned by those experienced in the psychology of deafness. Be this as it may, the results from this investigation firmly indicate the importance of viewing deafness in children in terms of a psychoneruological construct. From this point of view the importance of appropriate early life stimulation (brain activation) cannot be overemphasized.

INTERRELATIONSHIP OF VARIABLES

THE INTERCORRELATION OF SPEECHREADING WITH OTHER FUNCTIONS

The data obtained from the speechreading tests and the various measures of intelligence, perception, and educational achievement were analyzed using correlation techniques. The Pearson Product intercorrelations for the speechreading tests are presented in Table 86. High correlations were observed throughout the matrix with over two-thirds of the scores falling in the range of .80 to .98; only two of the correlations were below .70. Within each of the forms the total scores correlated highest with Words and Sentences; the same result obtained when all scores were combined into the Total Battery. Regardless of the rate of utterance Words and Sentences were more highly intercorrelated than either was with Phrases. The intercorrelations for Words at different speeds were .89 and above; for Sentences the coefficients ranged from .83 to .86; for Phrases the range was from .64 to .76.

It appears that a subject's score on one form of the battery was a good indicator of how he performed on any other form. Also, speechreading of single words and sentences was a more stable measure than perception of phrases. Although the correlations among the various forms of the test were high, one cannot assume that the different portions of the Speechreading Battery were equivalent. Previous analyses indicated that rate of utterance and length of message were important variables, each affecting ability to speechread. Nevertheless, Good Speechreaders, although their scores were lower, when confronted with faster speeds and longer messages demonstrated ability superior to the Poor Speechreaders.

The correlation analyses also confirmed that the filmed method of measuring speechreading ability is a reliable procedure. Hence, it can be assumed that it would be useful in evaluating ability to receive verbal communication in this manner under conditions of actual experience in the hearing world.

Results

Speechreading and Intelligence: The intercorrelation matrix for the scores from the speechreading tests, the Hiskey-Nebraska Test of Learning Aptitude and the measures of visual perception are presented in Tables 87 and 88. Age was highly correlated with speechreading achievement for both Good and Poor Learners. (Age also was correlated with all raw scores for the Hiskey-Nebraska, the visual perceptual tests and with the motor tests. The intercorrelations must be interpreted with this in mind.)

For the Good Learners significant correlations were observed with all of the Raw Scores of the Hiskey. The same pattern appeared for the

TABLE 86

INTERCORRELATION OF THE SPEECHREADING TESTS

	A Wds.	B Wds.	C Wds.	Total Wds.	A Phrs.	B Phrs.	C Phrs.	Total Phrs.	A Sent.	B Sent.	C Sent.	Total Sent.	Total Forms		
													A	B	C
B Words	.89														
C Words	.92	.94													
Total Words	.96	.98	.98												
A Phrases	.84	.75	.78	.81											
B Phrases	.76	.75	.75	.78	.76										
C Phrases	.74	.77	.73	.77	.85	.64									
Total Phrases	.87	.85	.85	.88	.91	.91	.85								
A Sentences	.89	.84	.85	.89	.83	.76	.76	.88							
B Sentences	.82	.79	.82	.83	.79	.80	.68	.85	.88						
C Sentences	.78	.79	.78	.81	.74	.77	.70	.83	.83	.86					
Total Sentences	.88	.85	.86	.89	.83	.82	.75	.90	.96	.96	.94				
Total Form A	.98	.89	.91	.96	.89	.79	.76	.92	.96	.87	.82	.93			
Total Form B	.92	.96	.94	.97	.82	.86	.77	.92	.90	.91	.86	.94	.93		
Total Form C	.92	.94	.97	.97	.80	.79	.82	.91	.89	.89	.89	.93	.93	.96	
Total Battery	.95	.95	.96	.98	.86	.83	.80	.93	.94	.88	.88	.95	.98	.99	.98

TABLE 87

SIGNIFICANT CORRELATION COEFFICIENTS BETWEEN SPEECHREADING AND PSYCHOLOGICAL VARIABLES FOR GOOD AND POOR LEARNERS

	Poor Learners (N=30)	Good Learners (N=30)	Total (N=60)
Age	.80*	.83*	.64*
Hiskey Raw Scores			
Bead Patterns	.57*	.64*	.62*
Memory for Color	.54*	.69*	.66*
Picture Ident.	.61*	.56*	.60*
Picture Assoc.	.65*	.81*	.69*
Paper Folding	.44	.74*	.65*
Visual Att'n Span	--[a]	.36	.42*
Block Patterns	.47*	.73*	.61*
Completion of Draw.	.69*	.77*	.62*
Hiskey Quotients			
Deviation Quotient	--	--	--
Bead Patterns	--	.47*	--
Memory for Color	--	--	--
Picture Ident.	--	.42	--
Picture Assoc.	--	--	--
Paper Folding	--	--	--
Visual Att'n Span	.47*	.49*	--
Block Patterns	--	--	--
Completion of Draw.	--	--	--
Perception			
Knox Cube R.S.	.58*	.76*	.65*
Knox Cube Quot.	--	.51*	.45*
Kohs Block R.S.	.53*	.63*	.54*
Kohs Block Quot.	.40	.56*	.49*
Tapping R.S.	.70*	.61*	.62*
Tapping Quot.	--	--	.35
Pattern Reproduc.	--	.79*	.62*
Dot Reproduction	--	.79*	.62*
Total Reproduction	--	.83*	.64*
Figure Ground	--	--	--

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[a] Only correlations significant at .05 level or less are reported.

[*] Significant at .01 level.

TABLE 88

SIGNIFICANT CORRELATION COEFFICIENTS BETWEEN SPEECHREADING AND PSYCHOLOGICAL VARIABLES FOR TOTAL SUBJECTS BY AGE

	4 & 5 yrs. (N=20)	6 & 7 yrs. (N-20)	8 & 9 yrs. (N-20)	Total (N=60)
Age	--[a]	--	--	.64*
Hiskey Raw Scores				
Bead Patterns	--	--	--	.62*
Memory for Color	.55	.45	--	.66*
Picture Ident.	--	--	--	.60*
Picture Assoc.	--	.48	--	.69*
Paper Folding	.53	--	.51	.65*
Visual Att'n Span	.58*	--	--	.42*
Block Patterns	--	.49	--	.61*
Completion of Draw.	.58*	.47	--	.62*
Hiskey Quotients				
Deviation Quotient	--	.48	.58*	.62*
Bead Patterns	--	--	--	--
Memory for Color	--	--	.44	--
Picture Ident.	--	--	--	--
Picture Assoc.	--	--	--	--
Paper Folding	--	--	.47	--
Visual Att'n Span	.46	--	--	--
Block Patterns	--	.50	--	--
Completion of Draw.	.49	--	--	--
Perception				
Knox Cube R.S.	--	.46	--	.65*
Knox Cube Quot.	--	--	--	.45*
Kohs Block R.S.	--	--	--	.54*
Kohs Block Quot.	--	--	--	.49*
Tapping R.S.	--	.55	--	.62*
Tapping Quot.	--	.51	--	.35
Pattern Reproduc.	--	--	--	.62*
Dot Reproduction	--	--	--	.62*
Total Reproduction	--	--	--	.64*
Figure Ground	--	--	--	--

[a] Only correlations significant at .05 level or less are reported.

*Significant at .01 level.

Poor Learners except for Visual Attention Span. The Poor Learners showed uniformly poor performance on this test of attention. When age was controlled (through the use of quotient scores) Visual Attention Span was shown to be intercorrelated with speechreading for both groups.

It is interesting that the Deviation Intelligence Quotient did not correlate with ability to read the lips although previous analyses demonstrated a significant difference in intelligence between the two learning groups. The range of IQ scores was restricted because those with scores lower than 80 were excluded from the study.

Age was held constant also by comparing the correlation coefficient by age level. These data are presented in Table 88. Although age played a significant role in acquisition of speechreading ability, when analyzed by age this factor was well controlled. With age controlled significant correlations with the Deviation IQ appeared for the two oldest groups. Previous investigations have reported inconsistent findings for the relationship between intelligence (as represented by the IQ score) and speechreading. Variation in results might be expected on the basis of the type of intelligence test employed and the population studied. If the intelligence quotient is viewed as a measure of integrative functioning one would assume that mental ability and speechreading were interrelated. The most significant correlations in this study were with subtests involving memory: Memory for Color, Paper Folding, and Visual Attention Span. The second most common were with test functions that were highly visual perceptual in nature, such as Completion of Drawings and Block Patterns. It should be emphasized, however, that in terms of mental functions it was the memory items which clearly differentiated Good and Poor Learners.

The measures of visual perception were highly intercorrelated with the Knox Cube Test, Kohs Block Design, Tapping, Pattern Reproduction and Total Reproduction. (On Figure-Ground the restricted range of scores prevented significant trends.) These results reveal the importance of visual perception and visual sequential memory in development of lipreading ability. However, according to the previous analyses, it is not that the Poor Learner lacks these skills but that the Good Learners have developed them to such a high degree. It is clear that in evaluating hearing impaired children educationally it is necessary to determine the status of their visual perceptual abilities.

Speechreading and Residual Hearing: In discussing the audiometric test results it was indicated that Good Learners had a somewhat higher level of residual hearing, especially on the right ear. The intercorrelation study also provided evidence of a relationship between speechreading and level of hearing. In this analysis three types of pure tone scores were considered: average for speech frequencies (500 Hz to 2000 Hz), better ear average for speech frequencies, Fletcher Average (average of two best frequencies in speech range) for both ears. These results are presented in Table 89. (When the correlation coefficients for Good versus Poor Learners were analyzed no significant relationships appeared, hence, are not reported.) As noted in Table 89, for the youngest subjects significant correlations between speechreading and all of the audiometric scores were observed, except for the Fletcher average on the left ear.

TABLE 89

SIGNIFICANT CORRELATION COEFFICIENTS BETWEEN SPEECHREADING AND HEARING LEVELS FOR TOTAL GROUP BY AGE

	4 & 5 yrs. (N=20)	6 & 7 yrs. (N=20)	8 & 9 yrs. (N=20)	Total (N=60)
Hearing Levels				
Right Ear Ave.	-.50	--[a]	--	--
Left Ear Ave.	-.46	--	--	--
Better Ear Ave.	-.53	--	--	--
Fletcher Ave-Right	-.45	-.61	-.48	-.27
Fletcher Ave-Left	--	--	--	--

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[a] Only correlations significant at .05 level or less are reported.

*Significant at .01 level.

The Fletcher Average for the right ear showed a significant association at all age levels and for the total sample. As age increased only the Fletcher average remained significant (although a low but significant correlation was observed with age, r = .28, partial correlation revealed no overlap, r = .11). We may conclude that residual hearing plays a significant role in development of verbal communication skills. Moreover, although these findings must be treated with caution, recent studies (Brannon, 1964) have indicated that it is the hearing level on the right ear which is of paramount importance. It is assumed that 60 percent of the fibers of the eighth nerve from the right ear project to the left hemisphere of the brain, the area considered critical for verbal learning. Whatever the reason, with the findings of the electroencephalographic study in mind, it appears that not only should the young deaf child have auditory stimulation, but despite the level of residual hearing on the right ear it should be activated.

Speechreading and Academic Achievement: Although age played an important role in the development of language skills, including reading, writing and speechreading, when age was held constant significant relationships were found between speechreading, reading, and writing. As noted in Table 90, there were high levels of intercorrelation between speechreading and all measures of reading, arithmetic and written language for both Good and Poor Learners. When partial correlations were computed, with age controlled, the level of association fell at .53. A more definitive analysis is shown in Table 91. When each age level was treated separately the intercorrelations remained unusually high.

Reading, both vocabulary and comprehension, was highly correlated with lipreading ability. Arithmetic was interrelated with speechreading for the six and seven year olds but not for the older children, although for the total group the coefficient again was significant.

The results for written language were not as consistent. For the total group all aspects were significantly related to speechreading. This was true also for the Poor Learners, except for the Words per Sentence Score. On the other hand, for Good Learners only Words per Sentence and Syntax were significantly related. These variations may be explained by the problem the younger deaf child faces in acquiring written language. At six, and even for many of the seven year old Good Learners, writing a story was a difficult task with many subjects producing only single words or lists; the result was a limited range of scores. Those at the older age levels wrote stories which could be scored more effectively. Nevertheless, the most consistent and highest correlations with speechreading occurred for Words per Sentence, Syntax, and Abstract/Concrete; productivity was not markedly interrelated.

These results support the hypothesis that speechreading and academic achievement are highly correlated, that those who develop ability to speechread develop higher levels of academic achievement. It may be assumed that learning to speechread and learning to read and write are dependent on development of generalized verbal facility. If so, it seems that the test battery was measuring this ability.

TABLE 90

CORRELATION COEFFICIENTS BETWEEN SPEECHREADING AND ACHIEVEMENT LEVELS FOR POOR AND GOOD LEARNERS

	Poor Learners (N=20)	Good Learners (N=20)	Total (N=40)
Reading			
Metro. Vocab. R.S.	.85*	.71*	.84*
Metro. Vocab. S.S.	.80*	.68*	.79*
Metro. Vocab. G.S.	.80*	.61*	.73*
Metro. Comp. R.S.	.69*	.79*	.69*
Metro. Comp. S.S.	.48*	.73*	.51*
Metro. Comp. G.S.	.54*	.79*	.57*
Arithmetic			
Metro. Arith.	.61*	.51*	.60*
Written Language			
PSLT Total Words	.67*	--[a]	.41*
PSLT Total Sent.	.51*	--	.38*
PSLT Words/Sent.	--	.55*	.56*
PSLT Syntax	.46*	.59*	.62*
PSLT Abs/Con	.47*	--	.62*

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[a] Only correlations significant at .05 level or less are reported.

*Significant at .01 level.

TABLE 91

SIGNIFICANT CORRELATION COEFFICIENTS BETWEEN SPEECHREADING AND ACHIEVEMENT LEVELS FOR TOTAL GROUP BY AGE

	6 & 7 yrs. (N=20)	8 & 9 yrs. (N=20)	Total (N=40)
Reading			
Metro. Vocab. R.S.	.84*	.74*	.84*
Metro. Vocab. S.S.	.83*	.66*	.79*
Metro. Vocab. G.S.	.72*	.70*	.73*
Metro. Comp. R.S.	.59*	.69*	.69*
Metro. Comp. S.S.	--[a]	.52*	.51*
Metro. Comp. G.S.	--	.65*	.57*
Arithmetic			
Metro. Arith.	.55	--	.60*
Written Language			
PSLT Total Words	--	--	.41*
PSLT Total Sent.	--	--	.38*
PSLT Words/Sent.	--	.64*	.56*
PSLT Syntax	.44	.69*	.62*
PSLT Abs/Con.	--	.51	.62*

[a] Only correlations significant at .05 level or less are reported.

*Significant at .01 level.

Speechreading and Motor Ability: When age was held constant, no significant associations occurred between speechreading and motor ability; see Table 92. However, previous analysis indicated a significant difference in motor performance favoring the Good Speechreaders. While such a relationship existed, good motor functioning and facility in speechreading were not necessarily related.

Summary

The correlation analyses confirmed previous findings which disclosed relationships among intellectual factors, visual perception, hearing and academic achievement and development of speechreading in young deaf children. The more facility in visual perception, the more highly integrated intellectually, the more auditory sensations received the better are the chances for development of speechreading as a language system.

FACTOR ANALYSIS

Farrant (1962) was among the first to study the intellective functioning of deaf children through factor analysis, employing methods pioneered by Thurstone (1941) and exemplified by the work of Guilford (1967). Briefly stated, factor analysis is a statistical technique for separating common sources of variance between intercorrelated measures when these measures are arranged in a certain manner. This statistical procedure permits drawing conclusions with respect to variables or traits, each of which are measured by a sub-group of tests. The factors that are derived are viewed as clusters which have implications for the understanding of mental processes.

Results

Good vs. Poor Learners: In the present study information was being sought concerning the question of whether those classified as Poor Learners were different in their intellectual organization as compared to Good Learners. Farrant observed that deaf children were less integrated in their intellectual functioning and that their abilities factored differently when compared to a matched sample of hearing children. Myklebust (1969) reported that Good and Poor Learners among hearing children also demonstrate different types of intellectual organization.

The data from 78 different variables for the 60 deaf subjects was analyzed using a computerized Factor Analysis program.[1] (For the measures of reading, written language, and arithmetic data were obtained from only the 40 older subjects.)

The data for all of the subjects on all of the variables are presented in Table 93. Six general factors were extracted which accounted for 74.7 percent of the variance. The largest factor, No. I, accounted for one-third

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[1] Northwestern University Computing Center Program No. 160: Principal Component Factor Analysis with Varimax Factor Rotation.

TABLE 92

SIGNIFICANT CORRELATION COEFFICIENTS BETWEEN SPEECHREADING AND MOTOR PERFORMANCE FOR POOR AND GOOD LEARNERS

	Poor Learner (N=30)	Good Learner (N=30)	Total (N=60)
Motor Performance			
Heath Rails	.44	.66*	.58*
Dynamometer-Right	.66*	.71*	.54*
Dynamometer-Left	.58*	.74*	.54*

[a] Only correlations significant at .05 level or less are reported.

*Significant at .01 level.

TABLE 93

ROTATED FACTOR LOADING FOR RESEARCH BATTERY FOR ALL SUBJECTS (N = 60)

Variable	Factor Loading	Variable	Factor Loading
Factor I		Factor II	
Speechreading		Age	.72
Total Words	.92		
Total Phrases	.94	Hiskey: Raw Scores	
Total Sentences	.92	Bead Pattern	.63
Total Form A	.93	Memory for Color	.57
Total Form B	.94	Pict. Ident.	.59
Total Form C	.95	Pict. Assoc.	.66
Total Battery	.95	Block Pattern	.57
		Complt. of Draw.	.72
Achievement			
Reading Vocab.	.75	Visual Perception	
Reading Comp.	.57	Knox Cubes	.67
		Kohs Blocks	.54
Pict. Story Lang. Test		Pattern Reproduct.	.63
Words per Sent.	.51	Dot Reproduct.	.72
Syntax	.53	Total Reproduct.	.71
Hiskey: Raw Scores		Motor Tests	
Memory for Color	.55	Heath Rails	.53
Pict. Assoc.	.53	Dynamometer-Right	.84
Paper Folding	.54	Dynamometer-Left	.80
Complt. of Draw.	.51		
Percent of Variance: 30.8		Percent of Variance: 12.2	

TABLE 93 - Continued

Variable	Factor Loading	Variable	Factor Loading
Factor III		**Factor V**	
Pict. Story Lang. Test		Hiskey Quotients	
Total Words	.84	Learning Quotient	.93
Total Sentences	.87	Bead Pattern	.66
Syntax	.53	Memory for Color	.78
Abs./ Con.	.72	Pict. Ident.	.56
		Vis. Att'n Span	.71
Achievement		Complt. of Draw.	.52
Reading Vocab.	.50		
Percent of Variance:	9.8	Percent of Variance:	7.1
Factor IV		**Factor VI**	
Hearing Levels		Achievement	
Right Ear Ave.	.85	Reading Vocab.	.55
Left Ear Ave.	.84	Reading Comp.	.73
Better Ear Ave.	.91	Arithmetic	.64
Fletcher Ave-Right Ear	.77		
Fletcher Ave-Left Ear	.79	Hearing Levels	
		Fletcher Ave-Right Ear	.58
Percent of Variance:	8.6	Percent of Variance	6.1
Total Variance: 74.8			

of the variance and included measures from the lipreading tests, the tests of reading and written language and four subtests of the Hiskey (Memory for Color, Picture Association, Paper Folding, and Completion of Drawings). Most of the variables that comprised this factor were concerned with some form of verbal symbolic functioning. Although considered more as measures of visual perceptual functioning the four items from the Hiskey were found to correlate significantly with speechreading as well as with reading and writing. Memory for Color and Paper Folding, representing spatial and sequential memory, have been shown to be highly related if not necessary for successful development of speechreading. Completion of Drawing was one subtest on which both Good and Poor Learners performed well but the results for the Good Speechreaders were superior. It appears that memory and visual perceptual abilities are required for speechreading as well as for reading and writing; perhaps for development of all types of verbal symbolic functioning.

Factor No. II accounted for 12.2 percent of the variance and contained a high loading of nonverbal, visual perceptual functions. This factor included age, the items from the Visual Perceptual Battery, six of the eight subtests of the Hiskey, as well as the Motor Tests. All of these items were highly correlated with age and probably represent an important facet of deaf intellectual ability. If the deaf child is to maintain homeostasis, visual perceptual abilities must develop as the child grows older.

By combining Factors I and II approximately 43 percent of the variance was accounted for. Factors III and VI were regroupings of the variables alreading considered but the combinations in which they appeared are important to understanding the intellectual functioning of deaf children. Factor III grouped the reading and writing scores as a dominant and separate verbal factor, distinct from speechreading. Factor IV isolated a hearing factor. It seems that hearing, even if it is minimal, is an influential factor in the organization of the deaf child's intellect. Factor V comprised the Hiskey Quotient scores, indicating that these subtests are a distinct factor independent of age. By implication this test measured the types of abilities that the deaf need for learning. Finally, Factor VI was unique in that it combined reading with degree of hearing on the right ear. This is another indication of the importance of hearing on the right ear for development of verbal symbolic processes.

From these results for the total group we conclude, along with Farrant, that the intellectual abilities of the deaf are less well integrated in comparison with the normal. They are less able to organize and associate verbal with nonverbal functions. There are important implications for the psychology of learning in deaf children. Moreover, these findings are noteworthy in terms of the educational methodologies which might be most advantageous.

To further explore the mental abilities involved in learning, the scores on the various tests also were factor analyzed by group. The findings for the Poor Learners are shown in Table 94. By comparing the results in Table 93 with those in Table 94 one observes a similar pattern. The loadings for each of the factors is comparable with separation of the verbal and nonverbal being almost identical.

TABLE 94

ROTATED FACTOR LOADING FOR RESEARCH BATTERY FOR POOR LEARNERS (N=30)

Variable	Factor Loading	Variable	Factor Loading
Factor I		Factor II	
Age	.63	Age	.68
Speechreading		Hiskey: Raw Scores	
Total Words	.88	Bead Pattern	.69
Total Phrases	.91	Memory for Color	.53
Total Sentences	.91	Picture Ident.	.62
Total Form A	.90	Picture Assoc.	.64
Total Form B	.90	Paper Folding	.78
Total Form C	.91	Vis. Att'n Span	.53
Total Battery	.93	Block Patterns	.75
		Complt. of Draw.	.73
Achievement			
Reading Vocab.	.75	Visual Perception	
Reading Comp.	.58	Knox Cubes	.85
		Kohs Blocks	.65
Pict. Story Lang. Test		Tapping	.52
Total Words	.55	Pattern Reproduct.	.67
		Dot Reproduct.	.73
Hiskey: Raw Scores		Total Reproduct.	.74
Memory for Color	.53		
Picture Assoc.	.52	Motor Tests	
Complt. of Draw.	.52	Heath Rails	.73
Picture Ident.	.50	Dynamometer-Right	.83
		Dynamometer-Left	.71
Visual Perception			
Tapping Raw Score	.55		
Percent of Variance:	28.8	Percent of Variance:	14.6

TABLE 94 - Continued

Variable	Factor Loading	Variable	Factor Loading
Factor III		Factor V	
Pict. Story Lang. Test		Hiskey Quotients	
Total Words	.76	Learning Quotient	.94
Total Sentences	.84	Bead Pattern	.56
Words/Sent.	.93	Memory for Color	.78
Syntax	.91	Paper Folding	.61
Abs./Con.	.90		
Percent of Variance:	13.3	Percent of Variance:	5.8
Factor IV		Factor VI	
Hearing Levels		Achievement	
Right Ear Ave.	.70	Reading Comp.	.74
Left Ear Ave.	.74		
Better Ear Ave.	.85		
Fletcher Ave-Right Ear	.80		
Fletcher Ave-Left Ear	.89		
Percent of Variance:	8.5	Percent of Variance:	5.0
Total Variance: 76.2			

Factor II for the Poor Learners included all of the Hiskey subtests. Moreover, for this group, the Fletcher Average for the right ear dropped out of Factor VI and became part of a general hearing factor (Factor IV).

For the Good Learners (Table 95) over 72 percent of the variance was accounted for by only five factors. If Factor V, which contained only negligible loadings from the Hiskey, were dropped then four factors comprised 68 percent of the variance. As with normally hearing children who are good learners, those who developed the better levels of ability to speechread, and acquired other verbal symbolic systems, demonstrated intellectual functioning which was more highly organized and integrated.

Factor I for the Good Learners contained 39.5 percent of the variance and included all of the speechreading tests, the subtests of the Hiskey, and the items from the visual perceptual battery and the motor tests, as well as the reading achievement tests. Except for the Syntax score from the Picture Story Language Test the verbal measures in the study were concerned with receptive processes. Despite this fact Factor III for the Good Learners was comprised exclusively of expressive functions, containing most of the items from the test of written language. Such separation of receptive and expressive functions did not occur for the Poor Learners. It seemed that the Poor Learner could not yet differentiate receptive and expressive processes.

For the Good Learner all facets of residual hearing intercorrelated as one factor, while for the Poor Learners only specific frequencies showed a clustering relationship. Again the findings demonstrated the importance of auditory sensation in the development of verbal symbolic behavior. For the Good Learner it was the capacity to integrage and to mobilize all of his abilities that distinguished him from the Poor Learner. This integration not only included verbal and nonverbal aspects of behavior but use of both visual and auditory experience.

Factor Analysis by EEG Group: Further factorial analyses were performed by classifying the Poor and Good Learners into groups on the basis of the EEG findings. These data are presented in Tables 96 through 99. The Poor Learners (Table 96) with positive findings manifested factor loadings similar to those observed when the Poor Learner group was treated as a whole; again the dichotomy of verbal and nonverbal functioning was apparent. However, the pattern was not as clear, with some overlap noted in Factor III in which motor and visual perceptual items were associated with reading and written language. The low number of subjects may have prevented development of more significant factor loadings.

The data in Table 97 indicated that the Poor Learners with normal electrocortical findings were more similar in intellectual organization to those calssified as Good Learners, with more integration of the verbal and nonverbal and better use of both visual and auditory sensation. For the Good Learners the EEG patterns were unrevealing (Tables 98 and 99). Whether the electroencephalogram was positive or negative, the Good Learners showed intellectual integration and organization. The only real difference occurred in use of hearing. Those with normal findings showed a tendency for hearing, especially on the right ear, to be closely related to reading and arithmetic.

TABLE 95

ROTATED FACTOR LOADING FOR RESEARCH BATTERY FOR GOOD LEARNERS (N=30)

Variable	Factor Loading	Variable	Factor Loading
Factor I			
Age	.83	Visual Perception	
		Knox Cubes R.S.	.74
Speechreading		Kohs Blocks R.S.	.61
Form A		Kohs Blocks Q.	.59
Words	.94	Tapping R.S.	.62
Phrases	.85	Pattern Reproduct.	.78
Sentences	.92	Dot Reproduct.	.82
Form B		Total Reproduct.	.84
Words	.94		
Phrases	.84	Motor Tests	
Sentences	.90	Heath Rails	.60
Form C		Dynamometer-Right	.71
Words	.95	Dynamometer-Left	.73
Phrases	.69		
Sentences	.84	Achievement	
Total		Read. Vocab. R.S.	.63
Words	.99	Read. Vocab. S.S.	.59
Phrases	.96	Read Vocab. G.S.	.52
Sentences	.95	Read. Comp. R.S.	.71
Form A	.96	Read. Comp. S.S.	.67
Form B	.99	Read. Comp. G.S.	.72
Form C	.97	Arithmetic	.56
Total	1.01		
Form A-Phrases/Sent.	.93	Pict. Story Lang. Test	
Form B-Phrases/Sent.	.93	Syntax	.51
Form C-Phrases/Sent.	.89		
Total-Phrases/Sent.	.98		
		Percent of Variance:	39.5
Hiskey: Raw Scores			
Bead Pattern	.61		
Memory for Color	.69		
Pict. Ident.	.56		
Pict. Assoc.	.84		
Paper Folding	.72		
Block Pattern	.71		
Complt. of Draw.	.75		

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TABLE 95 - Continued

Variable	Factor Loading	Variable	Factor Loading
Factor II		Factor IV	
Hearing Levels		Hiskey Quotients	
Right Ear Ave.	.85	Deviation IQ	.75
Left Ear Ave.	.85	Memory for Color	.84
Better Ear Ave.	.91	Vis. Att'n Span	.78
Fletcher Ave-Right Ear	.85		
Fletcher Ave-Left Ear	.79		
250-4000: Right Ear	.72		
250-4000: Left Ear	.69		
2000-4000: Right Ear	.75		
2000-4000: Left Ear	.74		
Percent of Variance:	10.9	Percent of Variance:	6.8
Factor III		Factor V	
Age	.54	Hiskey: Raw Scores	
		Bead Pattern	.52
Speechreading			
Form C-Phrases	.57	Hiskey: Quotients	
		Block Pattern	.72
Hiskey: Raw Scores			
Bead Pattern	.60		
Pict. Story Lang. Test			
Total Words	.86		
Total Sentences	.89		
Syntax	.54		
Abs./Con.	.86		
Percent of Variance:	10.8	Percent of Variance:	5.0
Total Variance: 72.8			

TABLE 96

ROTATED FACTOR LOADINGS ON RESEARCH BATTERY FOR POOR LEARNERS WITH POSITIVE EEG (N=12)

Variable	Factor Loading	Variable	Factor Loading
Factor I		Factor II	
Speechreading		Sex	-.66
Form A			
Words	1.00	Age	.66
Sentences	.75		
Form B		Hiskey Raw Scores	
Words	.98	Bead Patterns	.54
Phrases	.69	Memory for Color	.58
Form C		Pict. Ident.	.81
Words	1.00	Paper Folding	.51
Phrases	.71	Vis. Att'n Span	.74
Sentences	.83	Bead Patterns	.91
Total		Complt. of Draw.	.91
Words	1.02		
Phrases	.74	Hiskey Quotients	
Sentences	.80	Pict. Assoc.	-.58
Form A	.99	Block Patterns	.91
Form B	.92	Complt. of Draw.	.87
Form C	.98		
Total	1.00	Visual Perception	
Form A-Phrases/Sent.	.87	Knox Cubes R.S.	.77
Form B-Phrases/Sent.	.62	Knox Cubes Q.	.56
Form C-Phrases/Sent.	.83	Kohs Blocks Q.	.82
Total-Phrases/Sent.	.84	Tapping Reproduction	.72
		Pattern Reproduction	.69
Hiskey Quotients		Dot Reproduction	.78
Picture Assoc.	-.64	Total Reproduction	.79
Achievement		Motor	
Read. Vocab. R.S.	.65	Heath Rails	.69
Read. Vocab. S.S.	.66	Dynamometer-Right Hand	.77
Read. Vocab. G.S.	.69	Dynamometer-Left Hand	.61
Percent of Variance:	25.5	Percent of Variance:	18.9

TABLE 96 - Continued

Variable	Factor Loading	Variable	Factor Loading
Factor III		Factor IV	
Speechreading		Hiskey Quotients	
Form A Sentences	.53	Picture Ident.	.53
Hiskey Raw Score		Visual Perception	
Bead Patterns	.56	Figure Ground	.83
Vis. Att'n Span	-.57		
		Hearing Levels	
Hiskey Quotients		Right Ear Ave.	.74
Memory for Color	-.52	Fletcher Ave.-Right Ear	.58
Vis Att'n Span	-.70	R200-4	.73
		L200-4	.72
Written Language			
PSLT Total Words	.85	Achievement	
PSLT Total Sentences	.97	Read Comp. R.S.	.92
PSLT Words/Sentences	.54	Read. Comp. S.S.	.96
PSLT Syntax	.59	Read. Comp. G.S.	.95
PSLT Abs./Conc.	.97		
Visual Perception		Percent of Variance:	1[illegible].45
Kohs Blocks R.S.	.55		
Motor			
Heath Rails	.50		
Dynamometer	.58		
Achievement		Factor V	
Read. Vocab. R.S.	.54		
Read. Vocab. S.S.	.52	Hiskey Raw Scores	
Arithmetic	.62	Deviation IQ	.75
		Paper Folding	.65
Percent of Variance:	17.1	Hiskey Quotients	
		Bead Patterns	.70
		Paper Folding	.89
		Learning Quotient	.74
Factor VI			
		Visual Perception	
Hearing Levels		Knox Cubes Q.	.51
Better Ear Ave.	.66	Kohs Blocks R.S.	.60
Fletcher Ave.-Right Ear	.63		
Fletcher Ave.-Left Ear	.87	Written Language	
R250-4	.90	PSLT Words/Sentence	.82
L250-4	.94	PSLT Syntax	.78
Percent of Variance:	9.4	Percent of Variance:	10.5

Total Variance: 92.7

TABLE 97

ROTATED FACTOR LOADINGS ON RESEARCH BATTERY FOR POOR LEARNERS WITH NEGATIVE EEG (N=18)

Variable	Factor Loading	Variable	Factor Loading
Factor I			
Age	.89	Hiskey Quotients	
		Vis. Att'n Span	-.61
Speechreading			
Form A		Visual Perception	
Words	.89	Knox Cubes R.S.	.74
Phrases	.72	Kohs Blocks R.S.	.59
Sentences	.90	Kohs Blocks Q.	.57
Form B		Tapping	.78
Words	.90	Pattern Reproduction	.62
Phrases	.72	Dot Reproduction	.60
Sentences	.95	Total Reproduction	.62
Form C			
Words	.89	Motor	
Phrases	.76	Heath Rails	.61
Sentences	.82	Dynamometer-Right Hand	.74
Total		Dynamometer-Left Hand	.73
Words	.92		
Phrases	.88	Achievement	
Sentences	.94	Read. Vocab. R.S.	.68
Form A	.94	Read. Vocab. S.S.	.61
Form B	.95	Read. Vocab. G.S.	.63
Form C	.93	Read. Comp. R.S.	.77
Total	.96	Read. Comp. S.S.	.78
Form A-Phrases/Sent.	.89	Read. Comp. G.S.	.71
Form B-Phrases/Sent.	.92	Arithmetic	.56
Form C-Phrases/Sent.	.89		
Total-Phrases/Sent.	.95		
Hiskey Raw Score			
Bead Patterns	.73		
Memory for Color	.72		
Picture Ident.	.81		
Picture Assoc.	.87		
Paper Folding	.62		
Vis. Att'n Span	.62		
Block Patterns	.63		
Complt. of Draw.	.81	Percent of Variance:	39.0

TABLE 97 - Continued

Variable	Factor Loading	Variable	Factor Loading
Factor II		**Factor IV**	
Speechreading		Visual Perception	
Form A Phrases	.53	Pattern Reproduction	.80
		Dot Reproduction	.72
Hearing Levels		Total Reproduction	.76
Left Ear Ave.	.52		
Achievement		Percent of Variance:	7.6
Read. Vocab. R.S.	.61		
Read. Vocab. S.S.	.53		
Read. Vocab. G.S.	.66		
		Factor V	
Percent of Variance:	16.4	Hiskey Quotients	
		Paper Folding	.53
		Vis. Att'n Span	.54
		Learning Quotient	.97
		Percent of Variance:	6.5
Factor III		**Factor VI**	
Hearing Levels		Hiskey Raw Scores	
Right Ear Ave.	.92	Block Patterns	.66
Left Ear Ave.	.51		
Better Ear Ave.	.87	Hiskey Quotients	
Fletcher Ave-Right Ear	.93	Block Patterns	.93
Fletcher Ave-Left Ear	.74		
R 250-4	.93	Hearing Levels	
R 250-4	.67	Left Ear Ave.	.59
R 200-4	.79	L 200-4	.61
Percent of Variance:	9.5	Percent of Variance:	5.4

Total Variance: 84.3

TABLE 98

ROTATED FACTOR LOADINGS ON RESEARCH BATTERY FOR GOOD LEARNERS WITH POSITIVE EEG'S (N=16)

Variable	Factor Loading	Variable	Factor Loading
Factor I			
Age	.83	Hiskey: Quotients	
		Bead Pattern	.51
Speechreading		Vis. Att'n Span	.56
Form A			
Words	.93	Visual Perception	
Phrases	.92	Knox Cubes R.S.	.62
Sentences	.95	Kohs Blocks R.S.	.56
Form B		Tapping R.S.	.68
Words	.94	Pattern Reproduct.	.69
Phrases	.83	Dot Reproduct.	.71
Sentences	.93	Total Reproduct.	.76
Form C		Figure Ground	.57
Words	.88		
Phrases	.74	Motor	
Sentences	.89	Heath Rails	.58
Total		Dynamometer-Right	.56
Words	.98	Dynamometer-Left	.61
Phrases	.98		
Sentences	.97	Achievement	
Form A	.98	Read. Vocab. R.S.	.54
Form B	.99	Read. Vocab. S.S.	.53
Form C	.96	Read. Vocab. G.S.	.52
Total	1.01	Read. Comp. R.S.	.64
Form A-Phrases/Sent.	.97	Read. Comp. S.S.	.56
Form B-Phrases/Sent.	.95	Read. Comp. G.S.	.65
Form C-Phrases/Sent.	.96		
Total-Phrases/Sent.	1.00	Pict. Story Lang. Test	
		Words/Sentences	.68
Hiskey: Raw Scores		Syntax	.57
Bead Pattern	.51		
Memory for Color	.65		
Picture Ident.	.71		
Picture Assoc.	.82		
Paper Folding	.71	Percent of Variance:	39.9

TABLE 98 - Continued

Variable	Factor Loading	Variable	Factor Loading
Factor II		**Factor V**	
Motor		Hearing Levels	
Heath Rails	.66	Left Ear Ave.	.90
Dynamometer-Right	.56	2500-4000: Right Ear	.88
Dynamometer-Left	.54	2000-4000: Right Ear	.89
Pict. Story Lang. Test		Achievement	
Total Words	1.01	Read. Vocab. S.S.	.54
Total Sentences	.98	Read. Vocab. G.S.	.64
Abs./Conc.	.52		
		Percent of Variance:	8.3
Percent of Variance:	12.2		
Factor III		**Factor VI**	
Hearing Levels		Visual Perception	
Right Ear Ave.	.99	Figure Ground	.65
Better Ear Ave.	.80		
Fletcher Ave-Right Ear	.91	Achievement	
2500-4000: Right Ear	.73	Read. Vocab. R.S.	.69
2000-4000: Right Ear	.97	Read. Vocab. S.S.	.61
2000-4000: Left Ear	.57	Read. Comp. R.S.	.59
		Read. Comp. S.S.	.76
Percent of Variance:	10.0	Arithmetic	.85
		Percent of Variance:	7.5
Factor IV			
Hiskey: Quotients			
Deviation I.Q.	.93		
Picture Ident.	.53		
Picture Assoc.	.62		
Paper Folding	.56		
Block Pattern	.81		
Learning Quotient	.91		
Percent of Variance:	9.2		
	Total Variance:	87.0	

TABLE 99

ROTATED FACTOR LOADINGS ON RESEARCH BATTERY FOR GOOD LEARNERS WITH NEGATIVE EEG (N=14)

Variable	Factor Loading	Variable	Factor Loading
Factor I			
Age	.73	Hiskey: Quotients	
		Picture Ident.	.50
Speechreading			
Form A		Visual Perception	
Words	.90	Knox Cubes R.S.	.74
Phrases	.79	Knox Cubes Q.	.58
Sentences	.90	Kohs Blocks R.S.	.61
Form B		Kohs Blocks Q.	.74
Words	.96	Tapping R.S.	.65
Phrases	.83	Pattern Reproduct.	.79
Sentences	.90	Dot Reproduct.	.81
Form C		Total Reproduct.	.83
Words	.99		
Phrases	.72	Motor	
Sentences	.82	Heath Rails	.60
Total Battery		Dynamometer-Right	.72
Words	1.00	Dynamometer-Left	.69
Phrases	.95		
Sentences	.94	Achievement	
Form A	.91	Read. Vocab. R.S.	.56
Form B	1.00	Read. Vocab. S.S.	.49
Form C	.99	Read. Comp. R.S.	.63
Total	1.00	Read. Comp. S.S.	.63
Form A-Phrases/Sent.	.89	Arithmetic	.57
Form B-Phrases/Sent.	.93		
Form C-Phrases/Sent.	.88	Written Language	
Total-Phrases/Sent.	.97	PSLT Words/Sent.	.63
Hiskey: Raw Scores			
Bead Patterns	.62		
Memory for Color	.63		
Picture Assoc.	.78		
Paper Folding	.78		
Vis. Att'n Span	.53		
Block Patterns	.71		
Complt. of Draw.	.73	Percent of Variance:	38.4

TABLE 99 - Continued

Variable	Factor Loading	Variable	Factor Loading
Factor II		Factor IV	
Age	-.52	Hiskey: Quotients	
		Deviation I.Q.	.98
Hearing Levels		Memory for Color	.75
Fletcher Ave-Right Ear	.68	Block Patterns	.51
2500-4000: Right Ear	.66	Complt. of Draw.	.86
2000-4000: Right Ear	.56	Learning Quotient	.97
Achievement			
Read. Vocab. R.S.	.78	Percent of Variance:	7.3
Read. Vocab. S.S.	.84		
Read. Vocab. G.S.	.88		
Read. Comp. R.S.	.67		
Read. Comp. S.S.	.62		
Read. Comp. G.S.	.69		
Arithmetic	.52		
Pict. Story Lang. Test			
Total Words	.88		
Total Sentences	.89		
Syntax	.75		
Abs./Conc.	.76		
Percent of Variance:	19.4		
Factor III		Factor V	
Hearing Levels		Hiskey: Raw Scores	
Right Ear Ave.	.70	Bead Patterns	.66
Left Ear Ave.	.92		
Better Ear Ave.	.82	Hiskey: Quotients	
Fletcher Ave.-Right Ear	.68	Picture Assoc.	.59
Fletcher Ave.-Left Ear	.90		
2000-4000: Left Ear	.71	Motor	
		Dynamometer-Right	.55
Motor			
Heath Rails	.61	Pict. Story Lang. Test	
		Words/Sent.	.70
Percent of Variance:	9.5	Percent of Variance:	6.3

Total Variance: 80.8

Summary

The findings from the factor analysis study indicated that the intellectual abilities of deaf children are less organized than in the normal. However, the data suggest that deaf children who learn to speechread and who develop competence in reading and writing function in an integrated fashion more like hearing children. The factor linking the deaf speechreader and the hearing child appears to be development of verbal ability. Moreover, central nervous system dysfunctioning, as represented by positive signs from electroencephalographic studies, may be related to organization of intellectual abilities. Those classified as Poor Learners without positive findings were observed to be functioning in a fashion more like that of the Good Learners than like those who showed neurological deficits. Yet for those who had established speechreading ability the presence of positive EEG findings were not related to intellectual organization. In Poor Learners a central nervous system dysfunctioning may be one of the factors that prevents development of language.

TREND ANALYSIS

The findings from a trend analysis of the total research test battery, in which the Poor and Good Learners were compared are presented in Table 100. The data were analyzed using discriminant analysis techniques;[2] for this analysis 36 subjects were selected, 16 Poor Learners and 20 Good Learners. (The statistical program employed would accept data only when there were no zero scores--this was possible for 36 of the older children.) Aside from age and sex, 33 of the 78 variables were included. The results were highly significant. When the computer was presented with the data it correctly identified each of the subjects and assigned them to their proper grouping. In other words the analysis demonstrated that the battery employed in this investigation correctly discriminated between the Good and Poor Learners.

In examining the data in Table 100 we see that there was not a single variable on which the Poor Learners were superior and on only six were the groups comparable. The probability of such a trend occurring by chance is beyond the one percent level ($Z = 3.66$, $p \leq .01$). Hence, the data confirm the hypothesis that deaf children who develop speechreading ability demonstrate superior intellectual functioning, are more highly differentiated in terms of visual perceptual ability, may have or are using their residual hearing to advantage and have developed superior verbal symbolic skills.

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[2] Northwestern University Computing Center Program No. 169: Discriminate Function for Contrasting two Groups and Testing of Significance.

TABLE 100

COMPARISON BETWEEN GOOD AND POOR LEARNERS ON SELECTED VARIABLES FROM THE TOTAL RESEARCH BATTERY

	Poor Learners (N=16)		Good Learners (N=20)		
	Mean	S.D.	Mean	S.D.	In favor of:
Age in Months	100.25	14.42	94.15	13.67	Poor L.
Speechreading					
Total Words	60.63	19.29	88.95	7.76	Good L.*
Total Phrases	41.50	20.61	72.40	11.27	Good L.
Total Sentences	45.88	17.36	75.65	16.19	Good L.
Total Battery	54.31	19.29	81.70	9.51	Good L.
Hiskey Raw Scores					
Deviation IQ	91.88	9.34	103.60	10.04	Good L.
Bead Patterns	10.63	.89	10.95	.83	--
Memory for Color	11.94	1.88	13.05	1.64	Good L.
Picture Ident.	17.75	2.11	17.75	1.80	--
Picture Assoc.	9.75	2.29	10.15	1.76	--
Paper Folding	5.63	1.26	6.70	1.26	Good L.
Vis. Att'n Span	6.13	1.63	6.50	1.57	--
Block Patterns	8.06	2.91	9.60	4.04	Good L.
Complt. of Draw.	17.75	3.55	17.80	4.58	--
Visual Perception					
Knox Cubes	10.44	2.32	11.48	2.06	Good L.
Kohs Blocks	28.50	21.94	36.55	32.44	Good L.
Tapping	12.25	5.87	14.60	8.80	Good L.
Pattern Reprod.	33.44	6.36	36.45	4.51	Good L.
Dot Reproduction	32.56	5.67	34.45	5.61	Good L.
Total Reprod.	65.63	9.91	70.90	8.66	Good L.
Figure Ground	5.38	2.22	6.05	2.48	--
Hearing Levels					
Right Ear Ave.	107.56	4.16	103.75	8.55	Good L.
Left Ear Ave.	107.00	4.73	105.25	7.61	Good L.
Better Ear Ave.	106.13	5.44	102.15	9.09	Good L.
Fletcher Ave.-RE	104.81	6.16	97.65	6.53	Good L.
Fletcher Ave.-LE	105.44	6.40	99.25	6.68	Good L.
Achievement					
Word Knowledge	20.88	8.11	28.05	6.84	Good L.
Parag. Read.	20.88	11.68	28.00	12.96	Good L.
Arithmetic	17.31	6.80	20.20	7.42	Good L.
PSLT Total Wrds.	21.81	22.56	39.40	48.44	Good L.
PSLT Total Sent.	3.63	4.57	6.40	7.90	Good L.
PSLT Word/Sent.	2.49	2.17	4.52	2.84	Good L.
PSLT Syntax	34.13	27.79	58.10	30.56	Good L.
PSLT Abs./Conc.	4.13	4.94	7.30	5.28	Good L.

*Z = 3.66; p ≤ .01

CONCLUSIONS AND RECOMMENDATIONS

The primary concern of the present investigation was clarification of the factors which result in failure to develop speechreading. Underlying the study was the frame of reference that only through speechreading can the deaf child acquire the verbal facility necessary to attain an effective understanding of his environment. However, the findings not only were relevant to questions involving speechreading failure but also provided evidence on total learning processes and intellectual functioning among those deprived of hearing before the onset of language.

THE SPEECHREADING TESTS

The speechreading measures conclusively distinguished between good and poor speechreaders. Of importance is the fact that these measures differentiated between the groups as early as four years of age. Moreover, the tests demonstrated growth in ability to speechread. The deaf child developed ability to comprehend complicated messages at a faster rate of utterance up to nine years of age. The poor speechreader was not entirely devoid of this ability but developed this skill only minimally. By ten years of age he had ability only to speechread single words and was capable to this degree only when speed was held to a minimum. Although the Good Learners reached a plateau, it was not possible to determine such a level for the Poor Learners. Further study would be valuable in ascertaining growth levels in this type of child and to note whether he ever exceeds single word usage. It is clear that the poor lipreader has lessened ability because of failure to deal competently with phrases and sentences.

SPEECHREADING AND READ AND WRITTEN LANGUAGE

The data manifested a positive relationship between speechreading and other language skills. The good speechreader was superior in both reading comprehension and written language. Deaf children who acquired speechreading skills early learned to read and write with more ease. This interrelation of the language systems may be like that observed among the normally hearing, wherein reading and writing occur after acquisition of inner, receptive, and expressive auditory language. As speechreading is acquired as an inner language and used for relating to environmental experience for the hearing impaired child, he is able to further transduce experience into read and written language.

Although there were no statistically significant differences in family background or in early educational experience, there was a trend for early life stimulation to be more common in Good Learners. On the average the subjects did not receive language training until

27 months of age. The findings emphasize the need for early detection of hearing loss and optimum training programs which seem to be essential for actualization of potential for language.

SPEECHREADING AND VISION

The ophthalmological study did not distinguish between good and poor speechreaders but confirmed the high incidence of visual abnormality among deaf children. Although these visual problems had not interfered specifically with development of speechreading, further study is urgent in order to more fully understand this common finding. Inasmuch as vision is a primary avenue for learning for the deaf child, it is of utmost importance that visual processes be examined regularly so that he can have maximum use of this capacity for total adjustment.

SPEECHREADING AND INTELLECTUAL ORGANIZATION

The psychological, motor, and neurological findings were in agreement in demonstrating that the Good Learner not only was a superior lipreader, he was infinitely superior in his capacity to integrate intellectually. The Good Learner scored higher on all of the Hiskey-Nebraska Tests. The Poor Learners were inferior on measures of both sequential and spatial memory, functioning below the norms. On the other hand, the Poor Learners developed visual perceptual skills at an average level but the Good Learners were superior in this function. Tests of motor behavior also favored the Good Learners as having better physical organization. Moreover, although the neurological classification did not distinguish between Good and Poor Learners, there were more abnormal neurological signs among poor speechreaders.

The electroencephalographic studies were revealing in demonstrating that the brain of the deaf when compared with normally hearing children was more "silent," more reposed, not as activated as the normal. The influence of auditory stimulation in relation to speechreading, read and written language, perhaps should not have been unexpected. Although a child's residual hearing may not be of sufficient magnitude to aid in receiving speech, its role in activating electrocortical processes appears to have been highly significant. Of interest also is the correlation found between hearing on the right ear and development of speechreading. Further study is necessary for understanding the role of minimal auditory sensation for learning in the deaf child. The implications for the educator of the deaf are evident.

The factorial analyses revealed more highly integrated and organized mental abilities on the part of the Good Learner. In his capacity to integrate symbolic and visual perceptual experiences the Good Learner exhibited intellectual attainment and organization more similar to that of the normal child.

In hearing persons it is not easy to separate verbal from nonverbal, symbolic and nonsymbolic, because man uses both in a cohesive manner to learn and to control his environment. It would be unduly simplistic to specify causal factors, to declare that among Good Learners it is the excellence of integrative activity which produces the higher level of verbal functioning. Or the reverse, that it is the excellent verbal functioning which accounts for his degree of intellectual integration.

However, more normal use of psychological functions is related to acquisition of language. An implication for the educator is that for attainment of his potential the deaf child must have assistance with both - integrative and verbal learning must be fostered. More generally, the results from this investigation indicate a need for greater awareness of a difference in learning processes when deafness is present from early life. This difference appears to derive from altered brain activity and suggests the need for a new construct with respect to the psychoneurology of learning in deaf children.

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APPENDIX

CASE HISTORY

INSTITUTE FOR LANGUAGE DISORDERS
Northwestern University
Evanston, Illinois

Name Sex

Address

City State ZIP

Phone Birthdate
Month Day Year

School
Name City State

Father's name

Father's occupation

Highest grade attained by father

Mother's name

Mother's occupation

Highest grade attained by mother

Sisters and brothers:

Name	Birthdate	Deaf	Hearing
		☐	☐
		☐	☐
		☐	☐
		☐	☐
		☐	☐
		☐	☐
		☐	☐

I. BIRTH HISTORY

Mother's blood type ______ Father's ______

Is there an Rh incompatibility? Yes ☐ No ☐ Don't know ☐

Did mother have any previous miscarriages? Yes ☐ No ☐ When ______

Did mother have any still births? Yes ☐ No ☐ When ______

How long was the pregnancy? ______ Birthweight ____ lb. ____ oz.

Length of child at birth ______ inches

Complications during pregnancy with this child:

	Yes	No	If yes, during what month of pregnancy?
Bleeding	☐	☐	______
Nausea	☐	☐	______
Illnesses	☐	☐	______
Infections	☐	☐	______
Accidents	☐	☐	______

Other complications ______

	Yes	No	Remarks
Was there any false labor?	☐	☐	
Was labor induced?	☐	☐	
Were there any complications during labor?	☐	☐	What ______
Was the birth normal?	☐	☐	
Was the birth Breech?	☐	☐	
Were forceps used?	☐	☐	
Were transfusions given?	☐	☐	
Was oxygen given?	☐	☐	
Was the child placed in an incubator?	☐	☐	How long ______
Did the child have any scars?	☐	☐	Where ______
Are the scars still present?	☐	☐	

What additional medical attention was needed? ______

Child's color Normal ☐ Blue ☐ Jaundiced (yellow) ☐

II. EARLY DEVELOPMENT AND MEDICAL HISTORY

Did the child have any difficulties sucking? Yes ☐ No ☐

At what age did the child begin walking? ______________________________

Had the child had convulsions? Yes ☐ No ☐ When first observed ______

Is the child taking medicine because of convulsions? Yes ☐ No ☐

What ____

Childhood diseases:

	Yes	No	Highest Temperature	Age	Complications
Measles	☐	☐			
Chicken Pox	☐	☐			
Mumps	☐	☐			
Whooping Cough	☐	☐			
Scarlet Fever	☐	☐			
Encephalitis	☐	☐			
Influenza	☐	☐			
Diptheria	☐	☐			
Meningitis	☐	☐			
Poliomyelitis	☐	☐			
Tonsilitis	☐	☐			
Other:					

Has your child had his tonsils removed? Yes ☐ No ☐

Has he had any other surgery? Yes ☐ No ☐ Describe ______________

____

Does your child have frequent colds? Yes ☐ No ☐

Does your child have allergies? Yes ☐ No ☐ What type ______________

____

III. HANDEDNESS

	Right	Left	Either
Which hand does your child use to eat?	☐	☐	☐
Which hand does your child use to throw?	☐	☐	☐
Which hand does your child use to write?	☐	☐	☐

Handedness of Father: Right ☐ Left ☐ Mother: Right ☐ Left ☐

Number of right-handed brothers and sisters _______

Number of left-handed brothers and sisters _________

IV. HEARING

Check members of family who are deaf or hard of hearing:

☐ Mother
☐ Father
☐ Grandmother
☐ Grandfather
☐ Aunt
☐ Uncle
☐ Sister
☐ Brother
☐ Cousin
Others ______________________________
____
☐ None

What do you believe to be the cause of your child's deafness? __________
____

At what age was the child when you first suspected his hearing loss? ___

At what age was it confirmed? ______________________________

What did you do and what did the child do in order to communicate?

	Before Age 2		2 - 3 Years		3 Years to Present	
	Parent	Child	Parent	Child	Parent	Child
Pointing	☐	☐	☐	☐	☐	☐
Use of voice	☐	☐	☐	☐	☐	☐
Leading by hand	☐	☐	☐	☐	☐	☐
Gestures	☐	☐	☐	☐	☐	☐
Words	☐	☐	☐	☐	☐	☐
Connected Speech	☐	☐	☐	☐	☐	☐
Fingerspelling	☐	☐	☐	☐	☐	☐
Signs	☐	☐	☐	☐	☐	☐

V. EDUCATIONAL PROCEDURES

Before entering school:	Yes	No	How long	Age of child
Did the child have any home training?	☐	☐	____________	______
Did you use a correspondence course?	☐	☐	____________	______
Did you have supervision of a clinic?	☐	☐	____________	______
Did you teach informally without help?	☐	☐	____________	______
Techniques used:				
Lipreading	☐	☐		
Speech	☐	☐		
Gestures	☐	☐		
Fingerspelling	☐	☐		
Signs	☐	☐		
Did the child attend preschool clinic?	☐	☐	____________	______

Where ______________________

Hours per week ______________

What was the child taught? ______________________________

Did the child attend a nursery school for hearing children? Yes ☐ No ☐

For how long? ________________________ Age of child ________

Where ______________________________

Hours per week ________________________

Schools attended	Types of program	How long attended
____________	____________	____________
____________	____________	____________
____________	____________	____________

Has the child had special tutoring? Yes ☐ No ☐ Describe __________

____

Number of years formal training ______________________________

SPEECHREADING RECORD

INSTITUTE FOR LANGUAGE DISORDERS
Northwestern University
Evanston, Illinois

Form A
Slow Speed
Project: 18 fps

Name____ Date___________________________

Number___________________________________ Birthdate__________________________

School_______________________________________ Age____________________________

1. Foot	2			23. Candy	3		
2. Pants	3			24. Broken	1		
3. Shirt	1			25. Dirty	4		
4. Red	1			26. Open	3		
5. Play	4			27. Paper	3		
6. Short	4			28. Rocking Chair	4		
7. Stop	1			29. Grandmother	2		
8. School	2			30. Fire Engine	2		
9. Green	4			31. Valentines	1		
10. Store	1			32. Vegetables	4		
11. Car	1			33. Butterfly	4		
12. One	2			34. Television	3		
13. Door	2			35. February	3		
14. Five	3			36. Watermelon	1		
15. Cat	1			37. Five Flags	1		
16. Bow	1			38. A Bow	2		
17. Torn	3			39. Five Green Cars	1		
18. Flag	3			40. Some Short Pants	4		
19. Pencil	2			41. A Red Table	2		
20. Snowman	1			42. One Short Pencil	2		
21. Table	4			43. A Broken Pencil	2		
22. Blackboard	4			44. Some pants and a Shirt	2		

Form A Test continued Name____________________ Number____________

45. A Broken Rocking Chair	4		
46. A Blackboard and Some Paper	3		
47. The Boy Plays.	3		
48. The car stopped.	1		
49. Open the door.	3		
50. The green car stopped.	4		
51. Open the red door.	1		
52. The boy went to school.	3		
53. The cat played with the bow.	3		
54. The boy's foot is dirty.	4		
55. The boy ate watermelon.	3		
56. The boy has a torn shirt.	2		
57. The fire engine stopped at the school.	3		
58. The television is broken.	4		
59. There is a flag over the blackboard.	3		
60. The vegetables are on the table.	1		
61. The boy is sitting in a rocking chair.	4		
62. The butterfly landed on the boy's foot.	1		
63. The boy went to the store to buy some candy.	2		
64. We send valentines in February.	3		
65. Grandmother bought a watermelon at the store.	4		
66. The rocking chair is next to the television.	1		

Number Correct______________

Number Wrong________________

SPEECHREADING RECORD

INSTITUTE FOR LANGUAGE DISORDERS
Northwestern University
Evanston, Illinois

Form B
Normal Speed
Proj: 24 fps

Name______________________________ Date______________

Number____________________________ Birthday__________

School____________________________ Age_______________

1. house	3			17. light	3		
2. fat	4			18. three	1		
3. thumb	1			19. turn off	3		
4. white	4			20. toothbrush	1		
5. ten	2			21. flowers	4		
6. boat	3			22. movie	3		
7. milk	1			23. glasses	2		
8. hat	4			24. orange	3		
9. pig	2			25. airplane	3		
10. coat	3			26. letter	1		
11. fly	2			27. little	2		
12. old	4			28. Santa Claus	3		
13. farm	3			29. candy cane	4		
14. boots	2			30. grandfather	1		
15. drink	4			31. Christmas tree	4		
16. black	3			32. strawberries	3		

Form B Test continued Name________________________ Number______

33. animals	3			39. ten black boots	4		
34. peanut butter	1			40. a fat pig	4		
35. washing machine	4			41. a white flower	2		
36. January	1			42. three old airplanes	1		
37. ten boats	3			43. a little flower	3		
38. a thumb	2			44. a coat and a hat	2		

45. Some little animals	4	
46. a toothbrush and some glasses	3	
47. The bird flies.	4	
48. Drink your milk.	3	
49. Turn off the light.	2	
50. The black bird flies.	3	
51. Turn off the white light.	4	
52. The girl has new boots.	2	
53. Three boys watched a movie.	2	
54. The toothbrush is orange.	4	
55. The girl ate some strawberries.	2	
56. The boy went to the old house.	3	
57. Grandfather always wears glasses.	4	
58. The movie is about the farm.	4	
59. Santa Claus is reading a letter.	3	
60. The boy has a boat and an airplane.	2	

Form B Test continued Name______________________Number______

61. The boy ate a peanut butter sandwich.	2		
62. There are many animals on the farm.	2		
63. There is a candy cane on the Christmas tree.	4		
64. The big boy likes to eat strawberries and milk.	4		
65. We must wear a coat and hat in January.	1		
66. Santa Claus put some gifts under the Christmas tree.	4		

Number correct ______

Number incorrect _____

SPEECHREADING RECORD

INSTITUTE FOR LANGUAGE DISORDERS
Northwestern University
Evanston, Illinois

Form C
Fast speed
Proj: 24 fps

Name____________________________________ Date__________

Number________________________________ Birthday__________

School__________________________________ Age__________

1. tall	3			17. brown	4		
2. eyes	2			18. eat	4		
3. sick	2			19. doctor	3		
4. blue	1			20. heavy	1		
5. four	2			21. sweater	3		
6. soap	4			22. water	2		
7. shoes	4			23. money	3		
8. box	3			24. funny	2		
9. star	2			25. pick up	1		
10. socks	3			26. wagon	1		
11. bed	2			27. apple	4		
12. horse	4			28. telephone	3		
13. ball	2			29. birthday cake	2		
14. fire	3			30. ice cream cone	4		
15. cry	1			31. living room	4		
16. two	3			32. potatoes	1		

Form C Test continued

33. newspaper	3			39. four blue stars	4		
34. merry-go-round	2			40. a sick horse	4		
35. forty-seven	3			41. a blue sweater	2		
36. caterpillar	2			42. two tall doctors	4		
37. four shoes	3			43. a heavy sweater	3		
38. a bed	3			44. some soap and water	4		

45. a funny ice cream cone	2		
46. an apple and some money	2		
47. The boy cries.	3		
48. The horse eats.	1		
49. Pick up the ball.	3		
50. The brown horse eats.	2		
51. Pick up the blue ball	4		
52. The boy saw a fire.	1		
53. The shoes are in the box.	4		
54. The boy has two wagons.	1		
55. The girl ate an ice cream cone.	4		
56. The girl has pretty brown eyes.	2		
57. The man put water on the fire.	3		
58. The wagon is full of apples.	4		
59. The doctor visited the sick boy.	4		
60. The tall boy will eat his birthday cake.	4		

Form C Test continued

61. The children played on the merry-go-round.	2		
62. The newspaper is in the living room.	3		
63. The boy had four candles on his birthday cake.	1		
64. There is some money next to the telephone.	3		
65. The telephone is on the living room table.	1		
66. The boy saw a caterpillar on his brown socks.	2		

Number Correct _____

Number Wrong _______

RECORD FORM

OPHTHALMOLOGICAL EXAMINATION

Name ________________________________ Number ________

CATEGORY	No	Yes	Comments
1. History-Ocular			
a) Birth defect			
b) Glasses worn			
c) bifocals			
c) Orthoptics			
d) Surgery			
e)Trauma			
2. Nystagmus			
3. Pupils	Normal	Abnormal	
a) Equal			
b) Reaction to light			
direct			
consensual			
4. Neuro-ophthalmology			
a) Motility-versions			
b) Corneal sensation			
c) Convergence			
d) Visual fields			
5. Color Vision			
6. Ocular fundi			

Ophthalmological Examination continued

	Right	Left	Comments
7. Ocular Dominance			
8. Handedness			

	Norm	Mod.Abnorm	Path.	Comments
9. Accommodation Right eye				
Left eye				
10. Vision a) Unaided-dist. Right				
Left				
b) Unaided-near Right				
Left				
c) Corrected-dist. Right				
Left				
d) Corrected-near Right				
Left				

Ophthalmological Examination continued

	Norm	Mod.Abnorm		Path		Comments
11. Ocular Coordination		Eso	Exo	Eso	Exo	
a) Near						
b) Distance						
c) Hyper-distance						
Hyper-near						
12. Fusion and Stereopsis						
13. Refractive Error (under cycloplegia)						
a) Hyperopia Right						
Left						
b) Myopia Right						
Left						
c) Astigmatism Right						
Left						

NEUROLOGICAL EXAMINATION FORM

Name______________________________________Date__________________________Case________________

CATEGORY		FINDING				COMMENTS	'SYSTEM'
		Norm	Undet	Abnorm			
DEEP REFLEXES							
Biceps Jerk	R L						P---X
Triceps Jerk	R L						P---X
Wrist Jerk	R L						P---X
Ulnar Jerk	R L						P---X
Knee Jerk	R L						P---X
Ankle Jerk	R L						P---X
Hoffman Maneuver	R L						P
Palmomental	R L						P---X
Clonus	R L						P
Jaw Jerk							P
Snouting							P
Sucking							P
SUPERFICIAL REFLEXES							
Superficial Abdominal	R L						P
Cremasteric	R L						P
Plantar B	R L						P
Plantar C	R L						P

CATEGORY		FINDING				COMMENTS	'SYSTEM'
		Norm	Undet	Abnorm			
Plantar O	R						P
	L						
Plantar G	R						P
	L						
VISCERAL REFLEXES							
Pupillary	R						X
	L						
Light	R						X
	L						
Accomodation	R						X
	L						
Consensual	R						X
	L						
Pharyngeal	R						X
	L						
Pilomotor	R						X
	L						
Vasomotor	R						X
	L						
SENSORY MODALITIES							
Pinprick	R						Sm
	L						
Cotton Touch	R						Sm
	L						
Temperature	R						Sm
	L						
Vibration	R						Sm
	L						
Position	R						Sm
	L						
CORTICAL SENSATION							
Stereognosis	R						Co
	L						
Barognosis	R						Co
	L						
Two-point Discrimination	R						Co
	L						

CATEGORY	FINDING					COMMENTS	'SYSTEM'
		Norm	Undet	Abnorm			
Skin Writing	R L						Co
Extinction DDS	R L						Co
Touch Localization Unilateral	R L						Co
Touch Localization Bilat. Simulation	R L						Co
CRANIAL NERVES							
Smell I							X
Vision II	R L						X
Visual Fields	R L						X
Fundi							X
Optico-kinetic nystagmus VI III,IV,	R L						X
Jaw Movement - Vertical V	R L						P
Jaw Movement - Lateral							P---X
Facial Movement VII	R L						P---X
Taste VIII	R L						X
Hearing VIII	R L						X
Equilibrium VIII							Ce---X
Motion-palate; pharynx; other IX, X	R L						P---X
XI Motion-trapezius; sternocleidomast.	R L						P---X

CATEGORY	FINDING			COMMENTS	'SYSTEM'
	Norm	Undet	Abnorm		
Tongue-protrusion in midline XII					P
Tongue-alternating movement-vertical					Ce---P X
Tongue-alternating movement-horizontal					Ce---P X
CEREBELLAR					
Index-to-thumb	R L				Ce---P X
Drumming	R L				Ce---P X
Pronation-Supination	R L			— —	Ce---P X
F-F-N	R L				Ce---X
Heel-to-shin	R L				Ce---X
Check Reflexes	R L				Ce---X
Past Pointing	R L				Ce---S X
Metria	R L				Ce
Gait: rate of progression					Ce---P X
Gait: swinging arms	R L				P---X
Gait: tandem walk.					Ce---P X
Standing one foot	R L				Ce---P X
Hopping one foot	R L				Ce---P X
Romberg					S
Base					Ce---S

CATEGORY	FINDING			COMMENTS	'SYSTEM'
	Norm	Undet	Abnorm		
MIMIC MOVEMENTS					
Hand to nose-hand to ear					X
Grip hands-fingers facing tip to tip					X
Pat stomach-rub hand					X
ASSOCIATIVE MOVEMENTS					
With multiple postural acts	10" 20"				P---X
PRESENCE OF INVOLUNTARY movements: specify					X
MUSCLE TONE					
Arms	R L				P---X
Legs	R L				P---X
MUSCLE STRENGTH					
Arms	R L				P---X
Legs	R L				P---X
POWER					
Trunk					P---X

RECORD FORM

ELECTROENCEPHALOGRAPHIC EXAMINATION

NAME____________________________

DATE____________________________

EEG#__________

	DEGREE OF SEVERITY					(left)			FOCUS					(right)	
	Slight	Sl.Mod.	Mod.	Mod.Sev.	Sev.	F	C	P	O	T	F	C	P	O	T
I. Normal															
II. Abnormal															
A. Slow Waves															
1. Diffuse															
2. Focal															
B. Sharp Waves															
1. Diffuse															
2. Focal															
3. Others															
a. Centrencephalic															
(1) Under 3/sec															
(2) 3/sec															
(3) 6/sec															
b. Positive Spikes															

Sleep Record________

No Sleep Record________

Normal Abnormal

EEG# ________

EEG RECORD FORM (CONT'D)

				(left)						(right)				
C. Depression	Slight	Moderate	Severe	F	C	P	O	T	Mid	F	C	P	O	T
1. Diffuse														
a. L-sided														
b. R-Sided														
2. Focal														
D. Excessive Fast Waves														

III. Miscellaneous

A. Frequency of background rhythm:

under 5/sec	5-5.9	6-6.9	7-7.9	8-8.9	9-9.9	10-10.9	11-11.9	12-12.9	over 13/sec
(0)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)

B. Excessive Hyperventilation Response (duration)	slight		moderate	great
C. Asymmetry of Photic Driving Responses				
Depression on Left	slight		moderate	great
Depression on Right	slight		moderate	great
D. Quality of Photic Driving Responses	no	poor	good	excellent